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We'd like to hook a finger in your buttonhole and give you the whole story of our improved valve production—the new machines that we've developed ourselves, the brilliant time and labour saving techniques our bright boys have worked out, and the gratifying response to our drive for increased efficiency. But we'll spare you and simply say that the result of it all is a drop in the prices of a number of our valves. The 13E1 is one of them. Write to us and we'll tell you about the others.

EDISWAN 13E1. A tetrode with an outstanding performance for series or shunt regulation.

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26·0V	1·3A	800V	90W	800mA
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Vol. 33 No. 399

MAY 1961

Electronic Engineering

Incorporating ELECTRONICS, TELEVISION and SHORT WAVE WORLD

Managing Editor: H. G. FOSTER, *M.Sc., M.I.E.E., M.Brit.I.R.E.*

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Haddon **"STANDARD"** Saturable Reactors—Transductors operate from conventional A.C. line Voltages and provide a choice of D.C. Voltages for Control Windings. Selected from a wide range of individually designed and manufactured **SPECIALS** over past years, the **HADDON STANDARD RANGE** enable the discerning engineer to select **STANDARD EQUIPMENT** for Specific application.

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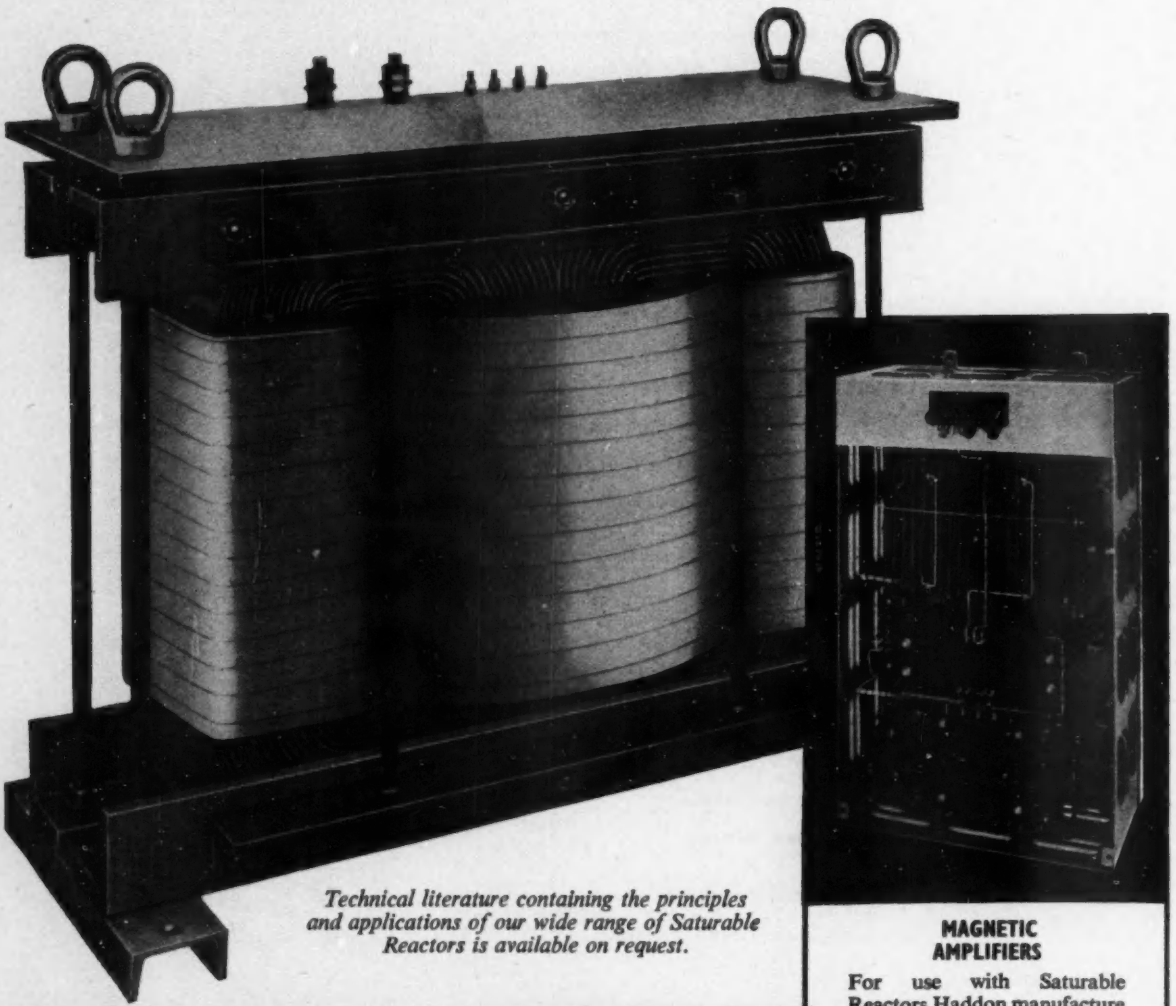

Technical literature containing the principles and applications of our wide range of Saturable Reactors is available on request.

MAGNETIC AMPLIFIERS

For use with Saturable Reactors Haddon manufacture a standard line of Magnetic Amplifiers.

Operating from 200/250V 50/60 c/s single-phase supply, with input of 0–5 mA DC in 2000/8000 ohms.

Illustrated above is the 1000W Magnetic Amplifier

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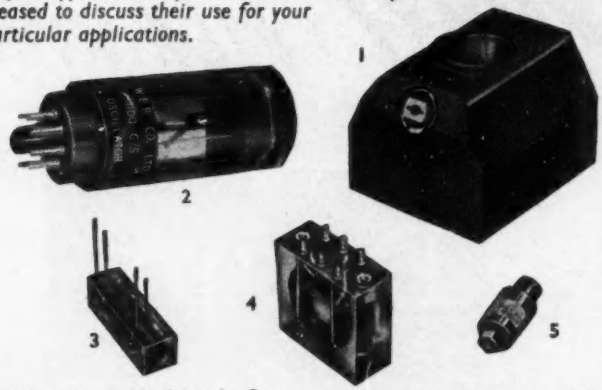
POTTED COMPONENTS

We are specialists in the design and manufacture of encapsulated components in Epoxy and Polyester resins. Illustrated below are a few typical examples. Our technical representative would be pleased to discuss their use for your particular applications.



1. Probe No. 4—Used by the Post Office for fault location on telephone cable routes.

2. Fixed Frequency Oscillator—On a standard octal base and encapsulated in epoxy resin. *Output:* 10 MW into a 600 ohm load. *Frequency:* As required within the range 700-2000 C.P.S. sinusoidal.

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4. Pulse Transformers—A toroidal winding on a mu-metal core: all connections are brought out to strong turret lugs moulded in the base of the casting.

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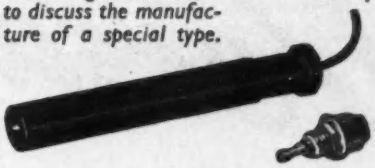
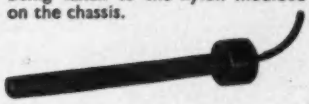
PLUGS & SOCKETS

The examples shown here are representative of the wide range available, and we are always happy to discuss the manufacture of a special type.



PROBE AND SOCKET

Designed with the contact shrouded in order to monitor various points of a curcuit, the monitor points being taken to the nylon moulded socket mounted on the chassis.



TEST PROBE

Designed to monitor any point that is terminated on a standard Ediswan Polytag.

PLUGS
No. 127 and 222

Manufactured specially for the G.P.O. An example of the development of small components undertaken by the Company.

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to withstand 55° C to 120° C

type A4

PRECISION WIREWOUND RESISTOR

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Rating:	½ Watt.
Temperature Coefficient:	Better than ±0.002% per °C or better than ±0.0015% per °C above 1,000 ohms.
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* **Datum racks now available to take all types of chart recorder**

* **Standard 19″ wide panels can be mounted on the same rack frame**

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DR/1

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with glove box for semiconductor devices

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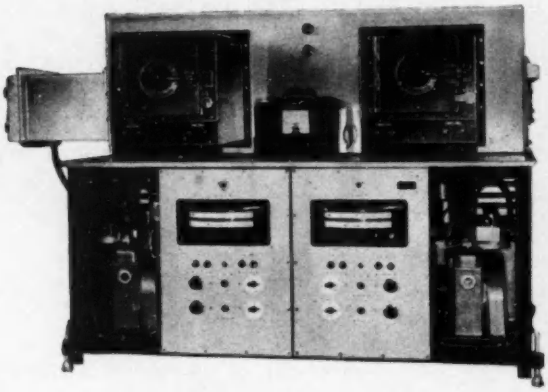
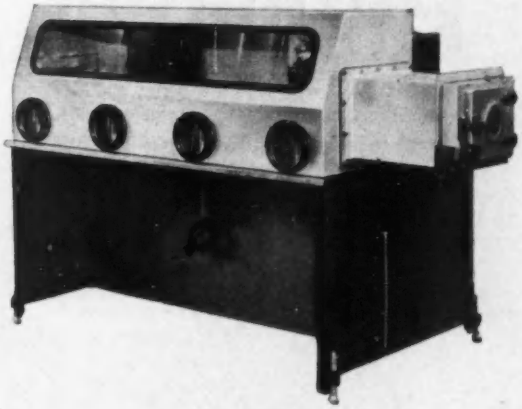
We design, manufacture and supply Vacuum Machinery to major companies in Great Britain and Overseas.





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Made throughout in polished stainless steel.
Single action door openings.
Rectangular with self spacings to suit.
Double-ended controls.
Electrical interlocking of air inlet and isolation valve.
Outer cover hermetically sealed.
Temperature Range 0-400 C.
or equivalent F.

Temperature Control: Normal ±7½°C. Special ±1°C.
Internal Spacing 7" x 8" x 18".
(can be altered to special requirements).
Vacuum Range: To 10^{-5} m.m.
Respective Vacuum Gauges incorporated.
Automatic air inlet valve on Backing Pump.
Visual Indicators and Fuses on all switches.
Flanged for fitting into Dry Box.

VACWELL ENGINEERING CO., LTD.

WILLOW LANE · MITCHAM · SURREY Tel: MITcham 8211 (3 lines)

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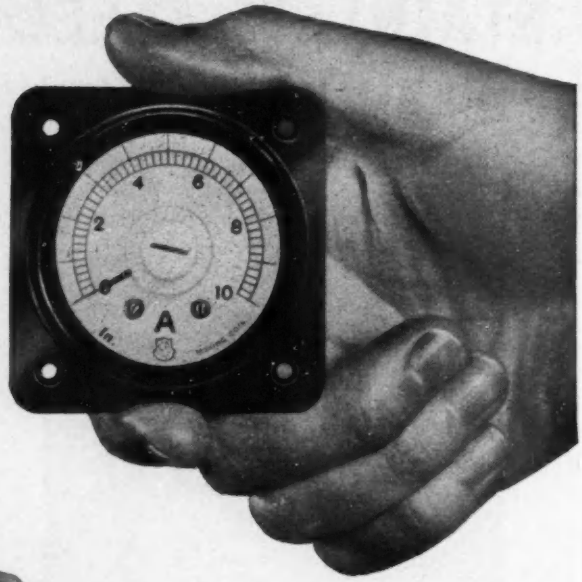
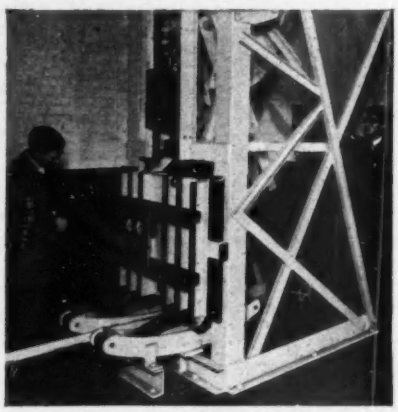
Crompton Parkinson



These are the first moving-coil and moving-iron instruments of their size and type to pass the Admiralty Shock Test as applied to instruments. They have been approved for use in fighting ships.

During tests on the machine illustrated below, both types of instruments successfully withstood shocks many times greater than any likely to be experienced under normal conditions.
The durability requirements of the industrial user are therefore absolutely assured. As well as being remarkably robust, these instruments are humidity-proof, easy-reading, space-saving, and accurate.



These Admiralty Pattern moving-iron and moving-coil ammeters and voltmeters have 240° circular scales and square or round bezels. Square bezel instruments have 2″ dials with scales 3¼″ long; round bezel instruments have 2½″ dials with scales 4¼″ long. The die-cast metal cases are nitrogen-filled and sealed. Dimensions conform with Ministry of Defence Specification DEF-62.
Full specifications on request.

Crompton Parkinson miniature INSTRUMENTS

Crompton Parkinson Limited., Crompton House, Aldwych, London, W.C.2. Telephone: Chancery 3333
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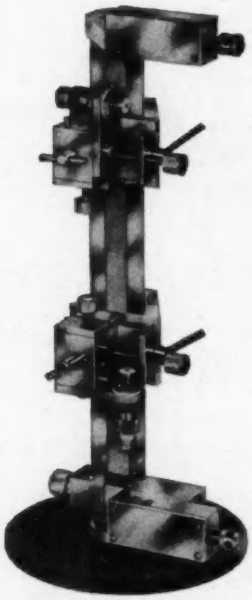
INVESTIGATIONS ON *VIBRATION DAMPING*
AND HIGH POLYMERE PLASTIC MATERIALS



JUNE 19-23
6th
International Instrument Show

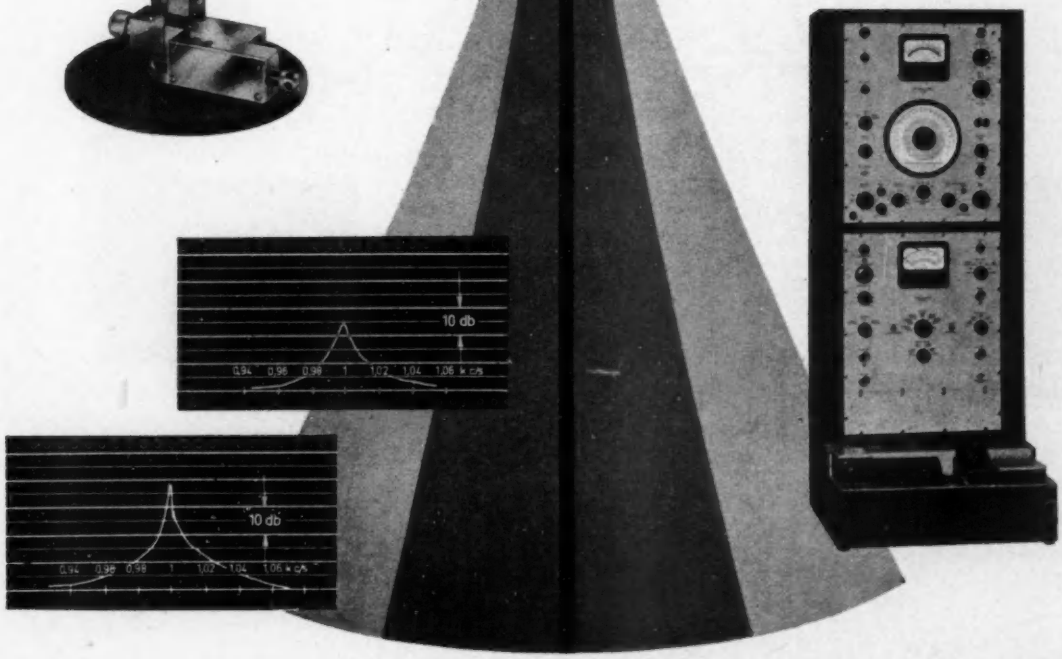
can now be conveniently carried out by means of the Complex Modulus Apparatus Type 3930 and Recorder Type 3324.

The instrumentation consists of a test jig in which a sample of the material should be mounted, and the associated electronic measuring equipment.

By electro-magnetically exiting the sample into mechanical vibration and recording its vibration/frequency response automatically on a level recorder the complex modulus of elasticity and the damping factor of the sample material is found.

The apparatus is designed for use over a very great temperature range from extremely low temperatures to about 250 ° C (480 ° F), which is of special importance for measurements on high polymere plastic materials.

To illustrate its use with regard to vibration damping materials two plots of the same resonance are shown below, giving the characteristics of a steel bar before and after applying a mastic deadener.



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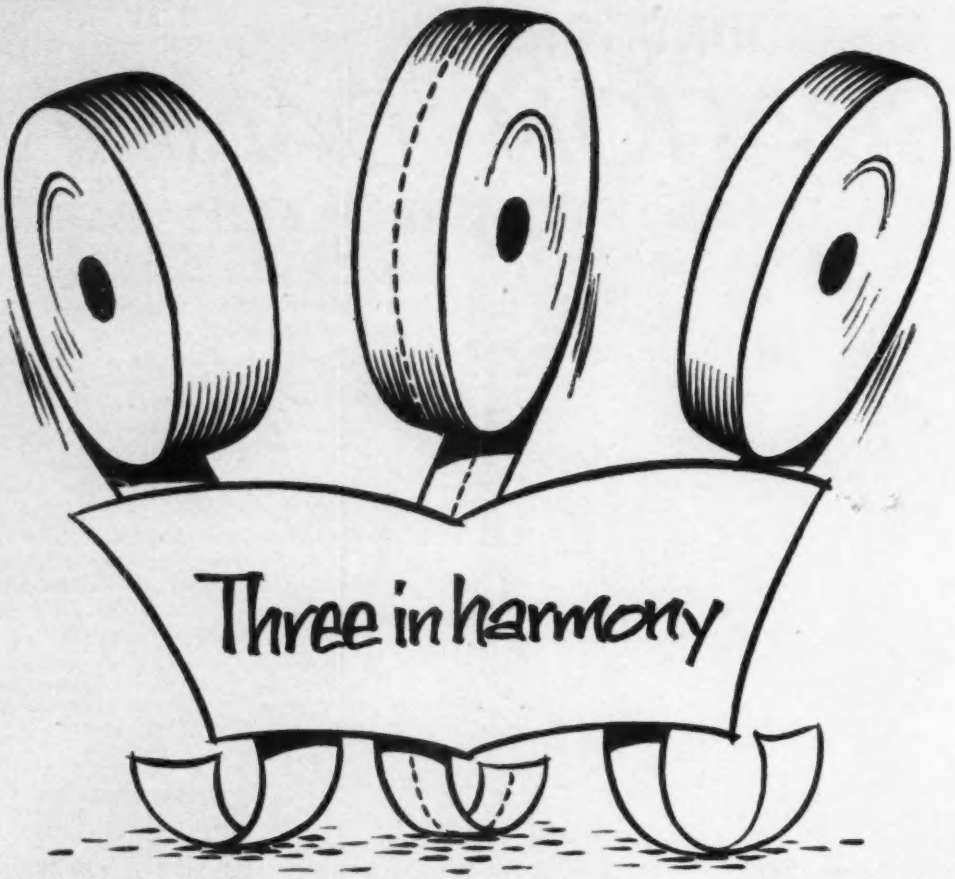
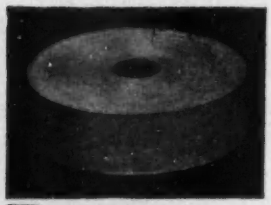
SALES AND SERVICE: B & K Laboratories, 4 TILNEY STREET, PARK LANE, W.1





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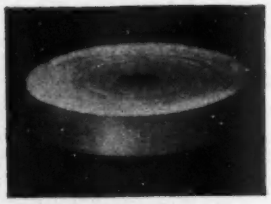
"Duraglas" Glass-fibre Tapes have many applications within the electrical insulation field such as conductor insulation, coil wrappings, core bindings, mechanical reinforcements, cable wrappings, and heat resistant protective coverings.

PYROFLEX Regd.

"Pyroflex" Asbestos Listing Tape has been specially designed for the electrical industry. "Pyroflex" is manufactured from carefully selected and purified fibres, and is suitable for a wide range of electrical insulation applications.



p.t.f.e.

p.t.f.e has exceptionally good di-electric properties, is non-tracking, non-flammable, resistant to moisture and totally unaffected by weathering conditions. As a result it has a wide application in the electrical industry in the form of tape for the insulation of cables, motors and transformers.

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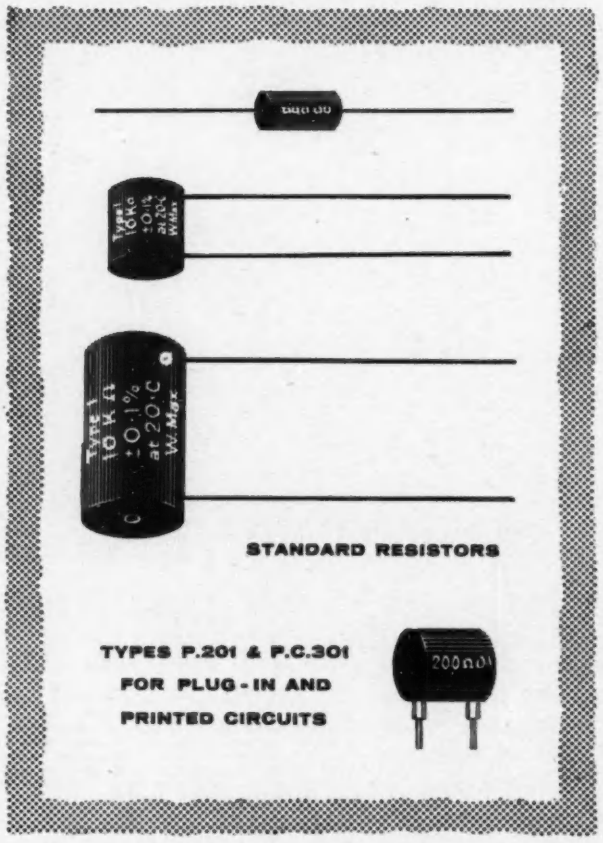
Even higher quality in **quantity!** through advanced techniques and extended capacity...

RIVLIN
precision wirewound resistors



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Rivlin Instruments Limited have developed a new method of encapsulation, based on epoxy resin, which has the following advantages:—

Wide Temperature Range—Proof against High Humidity. Suitable for use in the temperature range -55°C to +120°C with or without humidity, without significant effect on accuracy and stability.

Improved Stability. The new method results in resistors having stability of a very high order.

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Precious Metal Plated Terminations. In accordance with the best modern practice, the terminations are gold plated for ease of soldering and to prevent oxidation during storage.

STANDARD RANGE

Rating $\frac{1}{8}$W to 3W. Range 0.1Ω to 3MΩ tolerance to ±0.1% of nominal value or 0.01Ω whichever is the greater. Terminals, wire leads or solder lugs, fixing studs can be fitted.

PLUG-IN

Rating $\frac{1}{8}$W (other ratings to order). Range 50Ω to 200KΩ, tolerance ±0.1%. Designed for rapid range changing in recorders, computing networks, voltage dividers, etc. Phosphor bronze pins, gold plated for low contact resistance, plug into Electro Methods type D2 socket (special spacings to order).

PRINTED CIRCUIT

Rating $\frac{1}{8}$W (other ratings to order), range 50Ω to 200KΩ, tolerance ±0.1%. Designed specifically for Printed Circuit use with Phosphor Bronze pins, silver finished, spaced to suit standard Printed Circuit module.

NEW PRODUCTION CAPACITY

By the recent completion of additional factory, laboratory and office buildings our capacity and scope have literally tripled. Delivery is now 3 to 6 weeks according to size of order. Where high accuracy and consistent performance are vital considerations then RIVLIN is the resistor to specify.

ril

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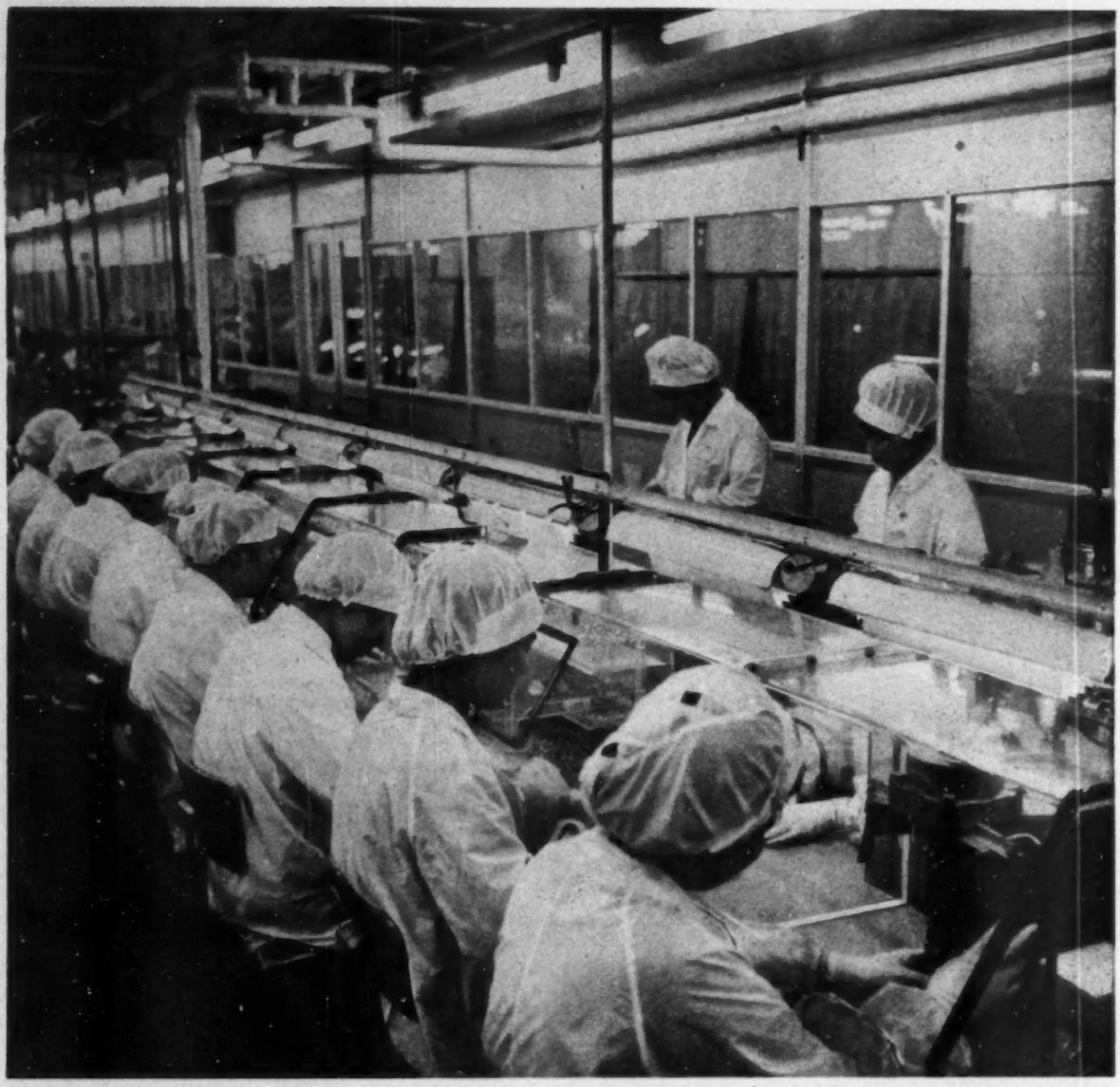


An NEC semiconductor device for every circuit application

The range of semiconductor products at NEC is perhaps the widest of any manufacturer. Entertainment or industrial, standard broadcast frequencies to microwave — NEC has a semiconductor device with the ratings and characteristics for your application. There's a wide selection of current ratings, operating temperatures, and mountings.

These are produced in NEC's new semiconductor plant where crystal surfaces are cleaned by 100 tons of hyper pure water daily. Every seal is tested in krypton isotopes, providing a failure rate suitable for the most critical applications.

A single source for semiconductors can mean a saving in time and costs. Just let NEC know your requirements and full technical data will be sent.

Types of NEC semiconductor devices

•PNP super-grown Germanium transistors •Germanium photo transistors •PNP alloy junction Germanium transistors •Silicon Mesa transistors •Germanium Mesa transistors •Germanium gold-bonded diodes •Silicon rectifiers •Silicon controlled rectifiers •Silicon capacitors •Zener diodes •Germanium point-contact mini-diodes •Silver-bonded diodes •Microwave mixer diodes • Silicon junction mini-diodes

Reliability The first NEC transistorized carrier telephone system was an NT & T installation in 1958 between Toyama and Takaoka, a distance of 15 miles. It consists of two terminal stations and a repeater station with 240 channels using 1,6000 transistors.

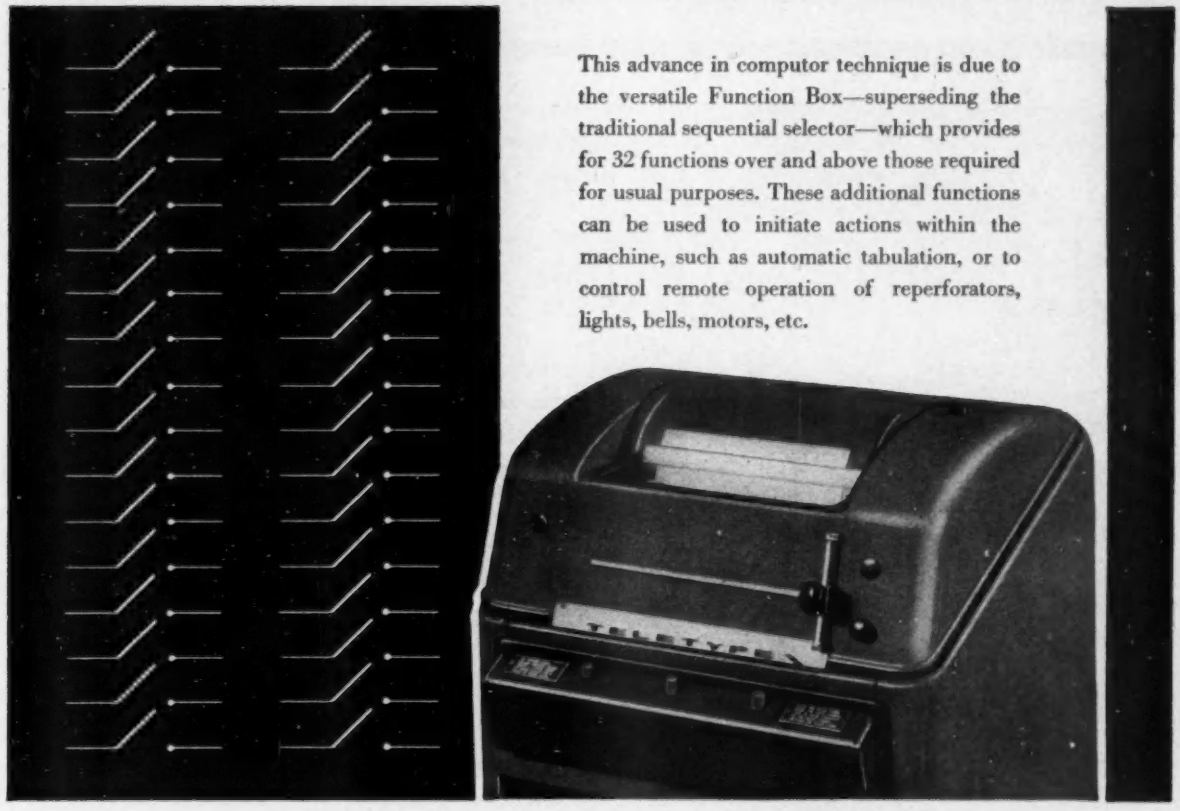
During last 14,000 hours of operation transistor failure has caused only two channel faults. This corresponds to a failure rate of 0.009% per 1,000 hours.

Communications Systems / Electronic Components NEC *Nippon Electric Co., Ltd.* Tokyo, Japan

ACCENT ON ACCURACY ...AND SPEED

This new read-out system brings greatly increased speed to what has always been the slowest stage in computor operation. With the Model 28 Page Printer it is possible, by using code combinations, to perform local and remote functions without sacrificing a single character code combination.

UNIQUE DIRECT READER FOR COMPUTORS AT A MODERATE COST



This advance in computor technique is due to the versatile Function Box—superseding the traditional sequential selector—which provides for 32 functions over and above those required for usual purposes. These additional functions can be used to initiate actions within the machine, such as automatic tabulation, or to control remote operation of reperforators, lights, bells, motors, etc.

No larger than an electric typewriter and with interchangeable typing heads, the Model 28 Page Printer requires little or no maintenance. Send for full details to:

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special industrial quality

NEWMARKET TRANSISTORS

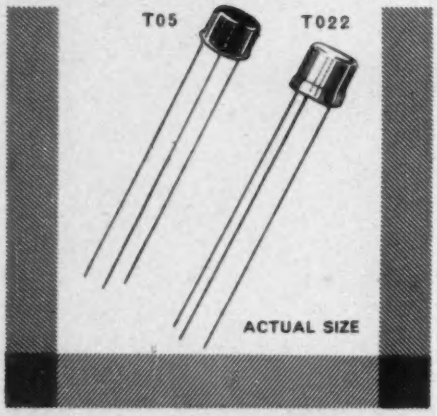
1955: 75mW 1957: 150mW 1959: 300mW

Our power ratings again increased—

1961: 500mW = 5 DECIWATTS

Now!

DECIWATT AUDIO TRANSISTORS



The pace of development at Newmarket Transistors has been so rapid that permissible dissipations in AF types are now reckoned in deciwatts (hundreds of milliwatts) rather than in milliwatts.

In addition to some units with ratings of five deciwatts, the 1961 NKT 200 range features higher voltages, higher currents, flatter betas and industry — standard T022 encapsulation. Where a T05 encapsulation is preferred an NKT 220 series is available with the same electrical specifications as the NKT 200 series.

NKT 201	High-current, high-voltage *output and switch.* 30V, 1A, beta at 500mA > 30.	**NKT 205**	Medium-gain, *mid-level amplifier.* 30V, beta at 1mA > 15.
NKT 202	General purpose *"donkey" switch.* 30V, beta at 25mA > 50.	**NKT 206**	Low-noise, *low-level amplifier.* 30V, beta at 1mA > 30, $N_f \leq 6$dB.
NKT 203	Extra high-gain *mid-level amplifier.* 30V, beta at 1mA > 50.	**NKT 207**	High-voltage *switch.* 60V, beta at 25mA > 50.
NKT 204	High-gain *mid-level amplifier.* 30V, beta at 1mA > 30.	**NKT 208**	High-current, medium-voltage *output and switch.* 20V, 1A, beta at 500mA > 30.

Data sheets are available direct from Newmarket Transistors Ltd

NKT **NEWMARKET TRANSISTORS LTD.**
EXNING ROAD, NEWMARKET Tel: Newmarket 3381

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1 Mc/s Counter with In-line Readout for less than £350

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The treble-3-six is proof that Venner gives a high technical performance AND versatility at low cost.

TYPE T.S.A 3336

- Frequency measurement to 1 Mc/s.
- Multi-period measurement over 1 to 10^7 cycles.
- Oven-controlled crystal.
- Six digit display.
- Sampling times 0.1, 1.0 and 10 sec.
- Gated random pulse counting.
- Mains or battery operation.
- Light, compact and portable.
- Venner proved performance packaged circuits throughout.

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R.E.C.M.F. Exhibition, Olympia.
30th May—2nd June

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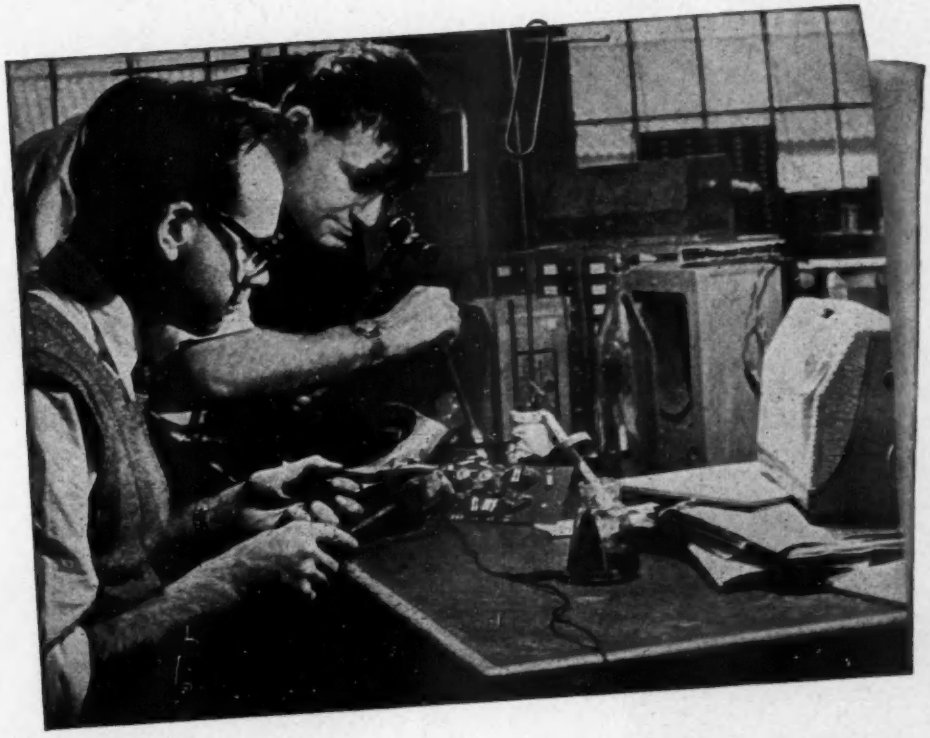
Kingston By-Pass, New Malden, Surrey. MALden 2442

Dear Sirs,

If you'll excuse the expression, my mate Wally (that's him with the hammer) thinks that your advertising is dull. I mean how about showing this picture with the words "Delicate adjustments to a transistor radio receiver at the G.E.C."? Something snappy like that. You'll have 'em rolling, believe me. Hoping you can use my idea because I could use five bob or so.

"Desperate"
Cocklehampton



Dear "Desperate",

As you may know, or will know if you read on to the end of this letter, G.E.C. make the most versatile range of semiconductors in the country. Seventeen hundred people up at Hazel Grove make nothing else. I mean ... what is your advertisement about?

"Puzzled"
G.E.C.

THE GENERAL ELECTRIC CO LTD SEMICONDUCTOR DIVISION SCHOOL STREET HAZEL GROVE STOCKPORT CHESHIRE

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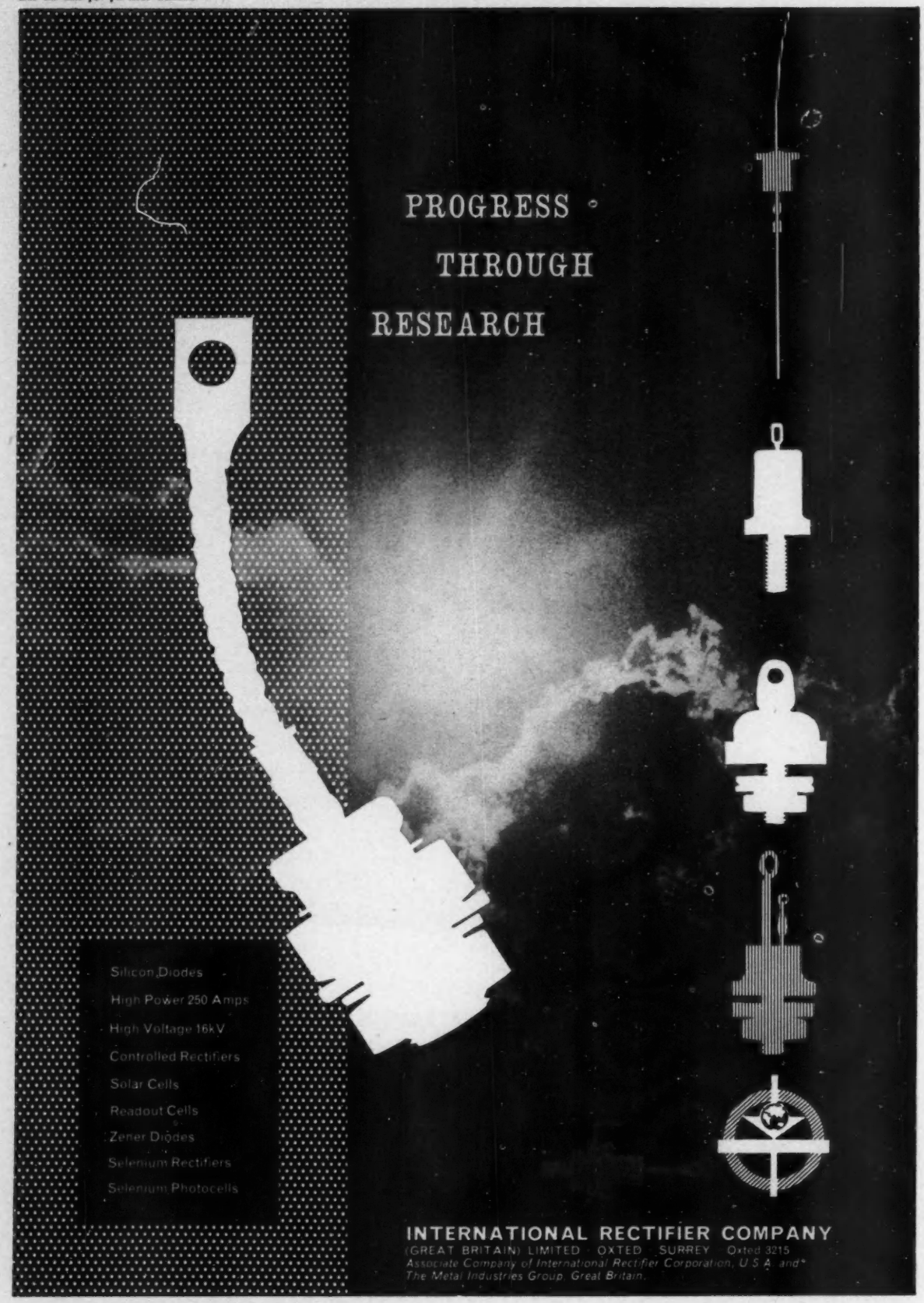

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FOR ADJUSTING CALIBRATION

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WIDE BAND SIGNAL GENERATOR

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Send for fully descriptive leaflet No. D45

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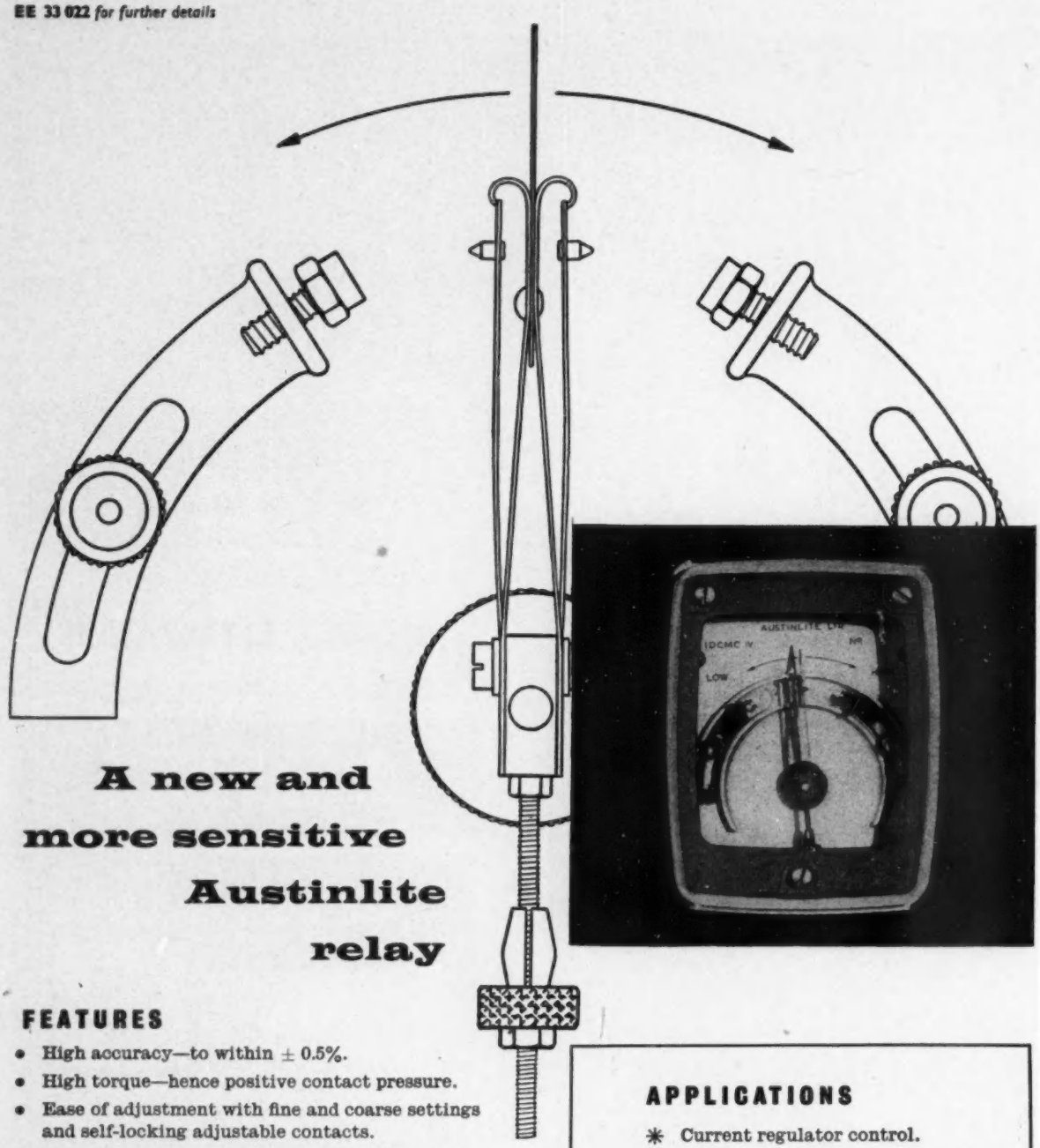

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- Choice of either two or four adjustable contacts.
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- Conforms to Post Office Specification P.T. 1025B.
- Suitable for current or voltage sensing on either D.C. or A.C.

APPLICATIONS

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- ✳ Voltage regulator control.
- ✳ Monitoring duties.
- ✳ Limiting duties.
- ✳ Equipment protection.

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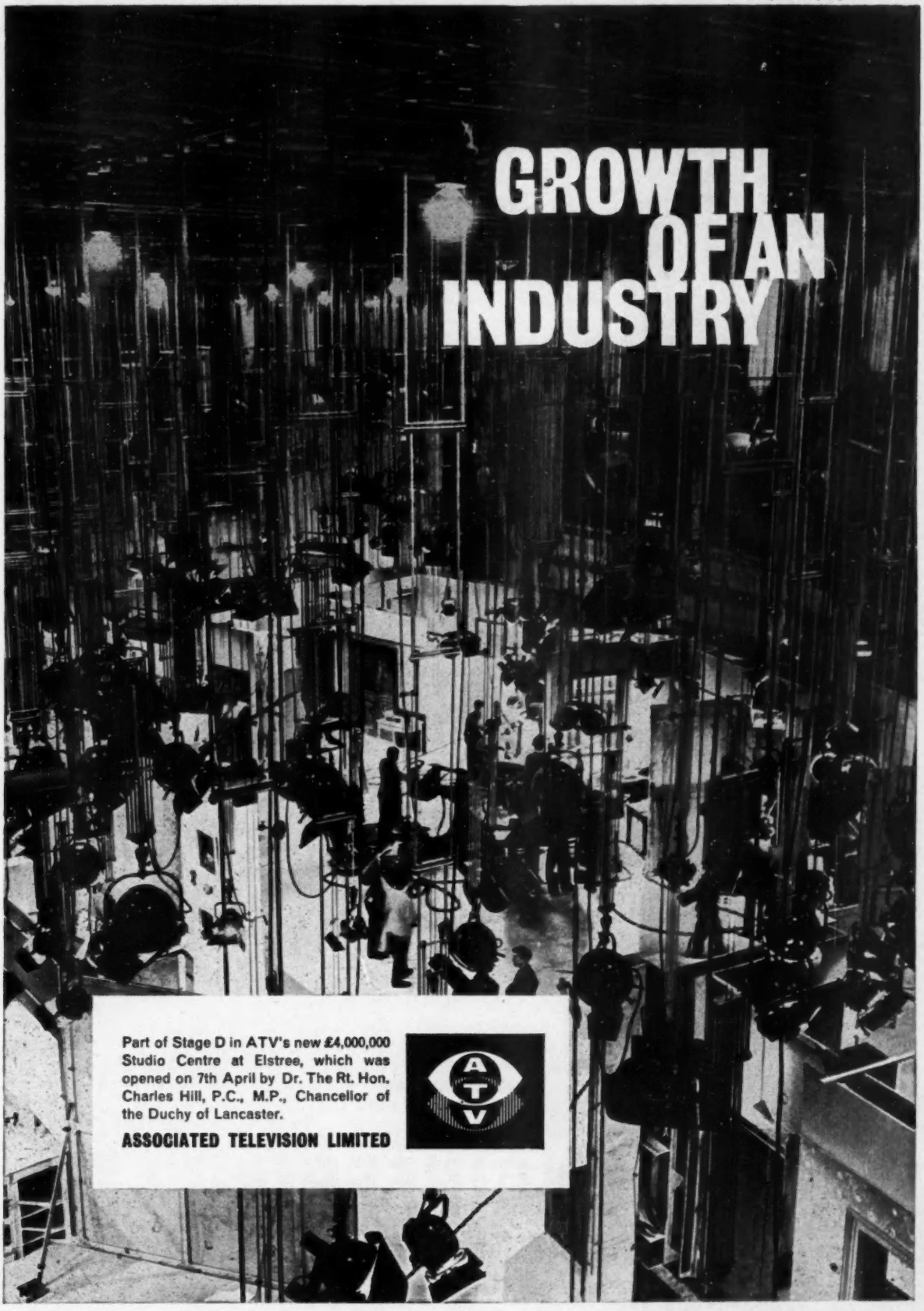
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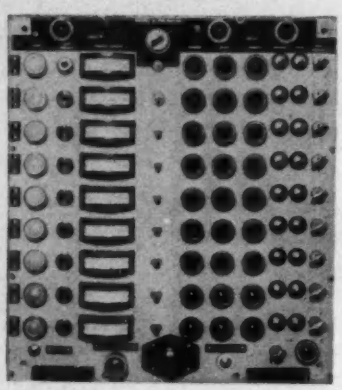
OF AN
INDUSTRY
Part of Stage D in ATV's new £4,000,000 Studio Centre at Elstree, which was opened on 7th April by Dr. The Rt. Hon. Charles Hill, P.C., M.P., Chancellor of the Duchy of Lancaster.
ASSOCIATED TELEVISION LIMITED
A T V



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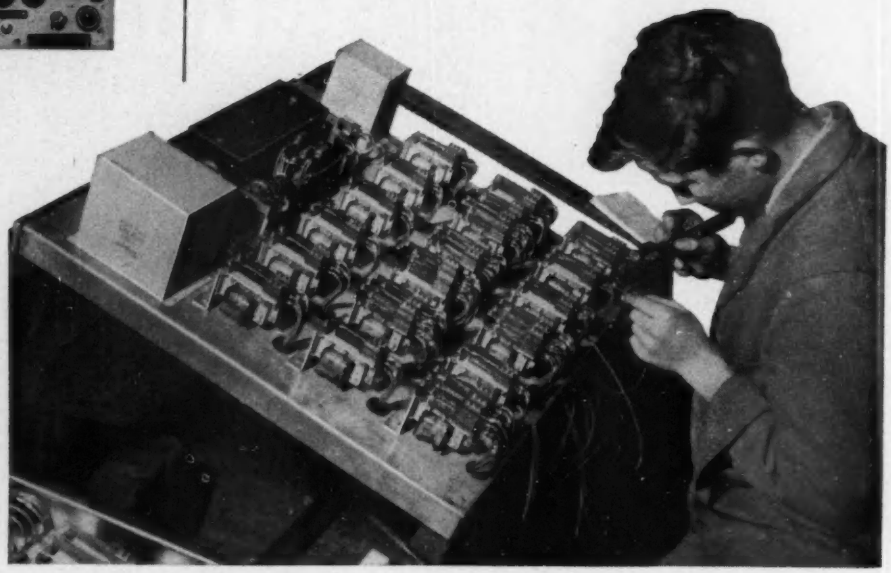
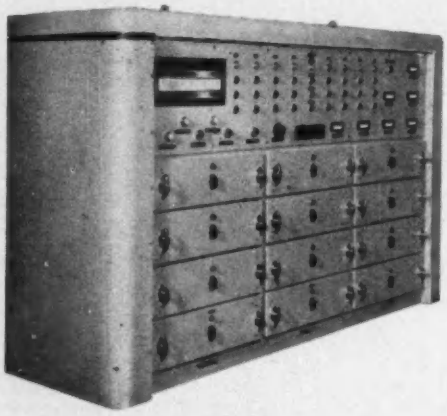
construction and assembly of modern control gear



Built to the design and specification of PEABODY LTD



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AYLING INDUSTRIES GROUP

Horsham, Sussex. Telephone: Horsham 3316

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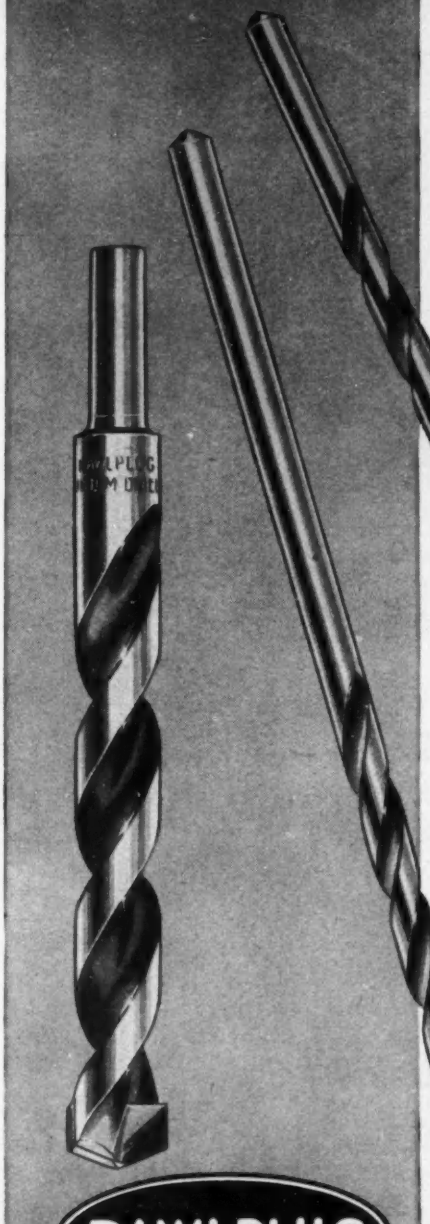

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DURIUM MASONRY DRILLS

GIVE THIS AMAZING PERFORMANCE

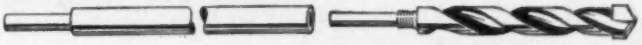
Durium masonry drills—first in the field—are still far, far ahead in quality, in performance, in *value*. It's important that you should know this, for the name Durium tends to be used loosely nowadays for any masonry drill of similar appearance. Be careful not to fall into this error, for there is positively *nothing* to equal a genuine Durium Drill. Look at these special Durium features:

ULTRA-FAST PENETRATION. Until you've tried Durium, you can have no idea of how quickly brick, tile, cement, slate, marble, etc., can be drilled. Only a Durium drill, with its tough, almost diamond-hard Durium tip, has such amazing speed of penetration and such sharp, silent, easy-cutting accuracy —specially valuable for tricky cavity walls.

PATENTED NO-CLOGGING FLUTE. The patented rapid-helix flute forces out spoil. This prevents clogging, and packing, even in such adverse conditions as damp brickwork.

LONGEST LIFE. The extreme toughness of the Durium tip, and the stronger backing given it by the specially designed flute, gives Durium Drills their astonishing ability to withstand the abrasive action of masonry which so quickly ruins ordinary drills. Durium Drills *last* longer. With the Free Sharpening Service in addition, even this long life is doubled!

BIG RANGE—DRILLING LENGTHS UP TO 16".



Durium Drills are made for all sizes of Rawlplugs from No. 6 to No. 30 (i.e. drill cutting diameters $\frac{1}{8}$" up to 1"), and for Rawlbolts sizes C, D, E & G. Durium Drills are also made in the Long Series to facilitate the work of laying conduits, cables, pipes, etc.—five cutting diameters ($\frac{1}{4}$" up to $\frac{3}{4}$") in 6" drilling lengths, and six cutting diameters ($\frac{3}{4}$" up to 1") with threaded ends to take extension rods which provide for overall drilling lengths of approximately 12" and 16".

HAND OR POWER. Durium Drills can be used very successfully in an ordinary wheelbrace, but for large-scale use and maximum performance, a Rawlplug R.P.2. Two Speed Electric Drill is recommended. At the lower speed of 420 r.p.m. this easy-to-handle power tool gives quite sensational results with Durium Drills.

FREE RE-SHARPENING SERVICE. When your Durium Drill begins to lose its keen sharpness—and this happens at long last even with Durium! —return it to us with the complimentary voucher supplied with it and we will re-sharpen FREE!

Also in the Durium range are Durium tipped Glass Drills, and Durium tipped Hammer Drills for percussion drilling. Write now for free illustrated literature containing full details of these and other Rawlplug hole-boring tools and Rawlplug Fixing Devices.

Durium Drills are supplied in the bright orange and blue metal containers clearly marked Rawlplug Durium. Look for the name DURIUM on the drill shank—no other is a genuine DURIUM DRILL.

MASONRY DRILLS
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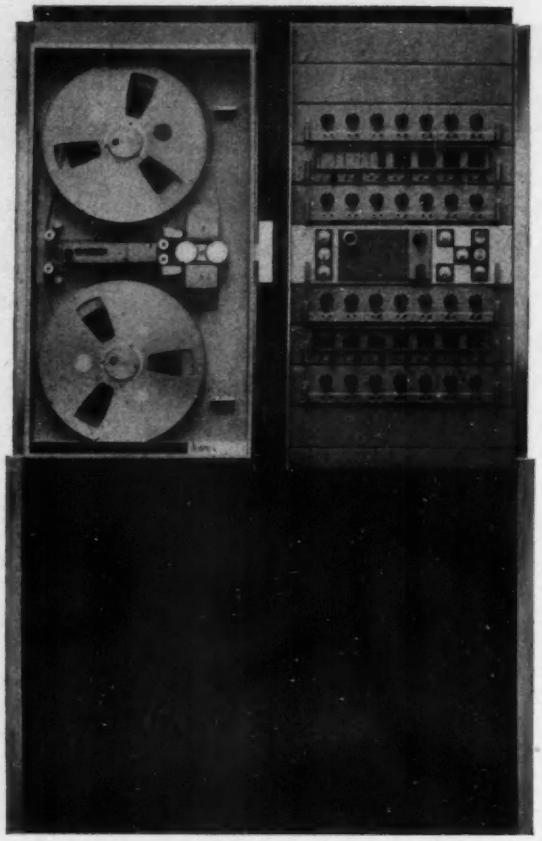
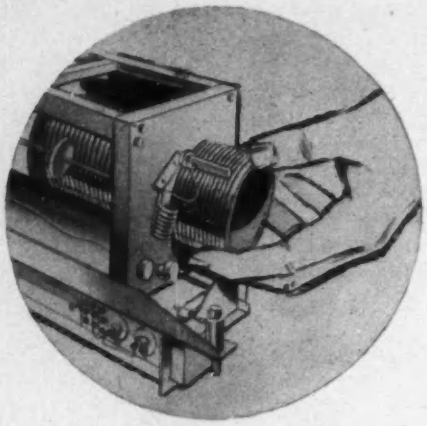


The AMPEX FR-600 is an advanced-design data recorder with twice the capacity of conventional recorders. Most analogue recorders can only record 24 minutes of 100 Kc data on a 14-inch reel of 1 mil tape. The FR-600 will record 48 minutes of the same data on the same reel of tape. The reason – greater bandwidth at a given speed . . . 125 Kc at 30 ips, for example. Many data-runs are 30 minutes or longer, requiring a stand-by recorder to pick up where the first leaves off . . . an expensive price for a few extra minutes of recording time. The FR-600 literally does the work of two conventional machines by enabling double record time for any given bandwidth, or double bandwidth for any given record time . . . 250 Kc at 60 ips, for example. Another cost-saving feature is the tape shuttle which automatically scans any portion of the tape, eliminating the need for a separate loop recorder. Modular plug-in, solid-state electronics warm up in less than 10 minutes, and FM amplifier drift is less than one percent in 24 hours. Other advanced features of the FR-600 include pneumatic tape guiding, tension sensing and control, adjustable search speed and fourteen miniature monitor oscilloscopes. For complete information write Ampex Great Britain Limited, Arkwright Road, Reading, Berkshire, England. AMPEX

The AMPEX CP-100 is a compact, extended-frequency instrumentation tape recorder/reproducer. Tape transport, motor drive amplifier, heads, power converter, controls and all-transistorized plug-in record/reproduce electronics are contained in a single 13¼" x 19" x 33¼" mobile case. The CP-100 operates on 28-volt DC, with 48 to 400 cycle converters available for other power sources. Data is recorded by direct or FM carrier techniques on up to 14 analogue tracks. The CP-100 offers frequency response to 200 Kc at 60 ips or expanded recording time of 24 minutes for 100 Kc data at 30 ips on a standard 10½" reel. Transport tape speeds – 1⅞, 3¾, 7½, 15, 30 and 60 ips – and plug in frequency determining units and equalizers associated with tape speeds, may be quickly changed. The versatile and mobile CP-100 performs reliably over a temperature range of from −50° F to +160° F, up to an altitude of 10,000 feet, in relative humidities to 95%... and is designed to withstand shocks and vibrations encountered in rugged mobile testing applications. This recorder may also be rack mounted if desired. For complete details write Ampex Great Britain Limited, Arkwright Road, Reading, Berkshire, England. AMPEX



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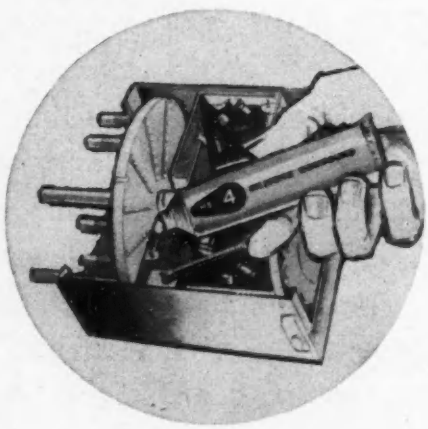
MS Technical Service Department exists to advise you on problems that silicones might help to solve. Consult our team of experts who have a real understanding of the application of silicones in industry based on ten years of experience.

Write for detailed information on any one of the products mentioned here or for our new, illustrated booklet "Silicones in Electronics" (A 13). **And don't forget to visit our stand at the RECMF exhibition—No. 459 in the gallery.**



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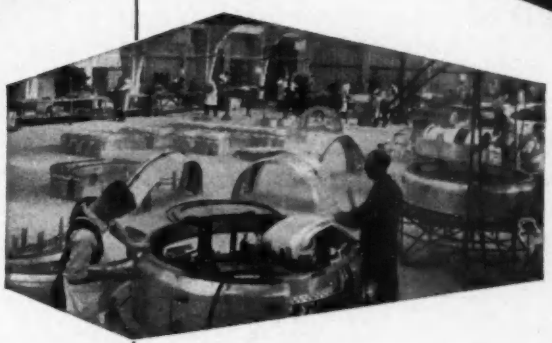

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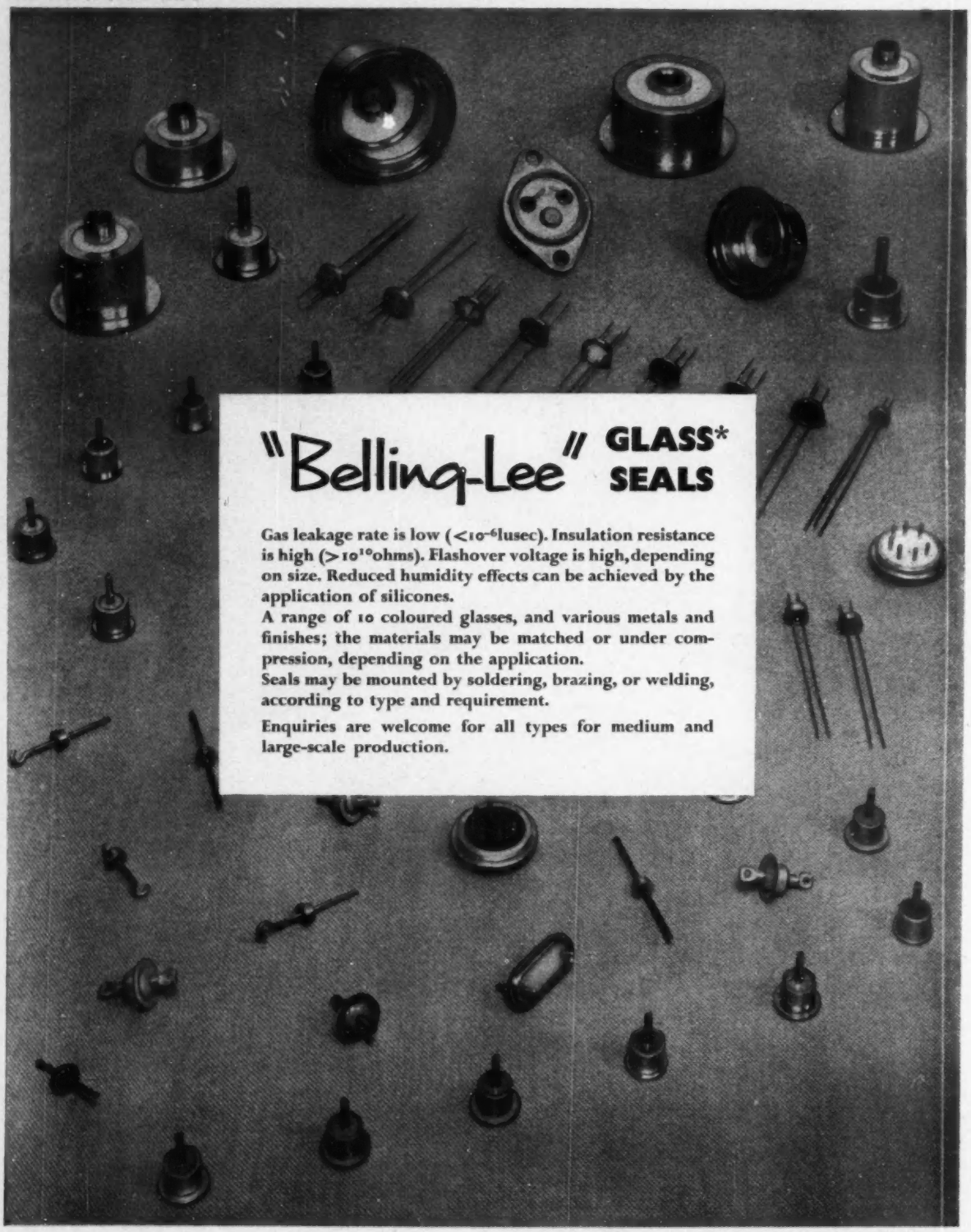

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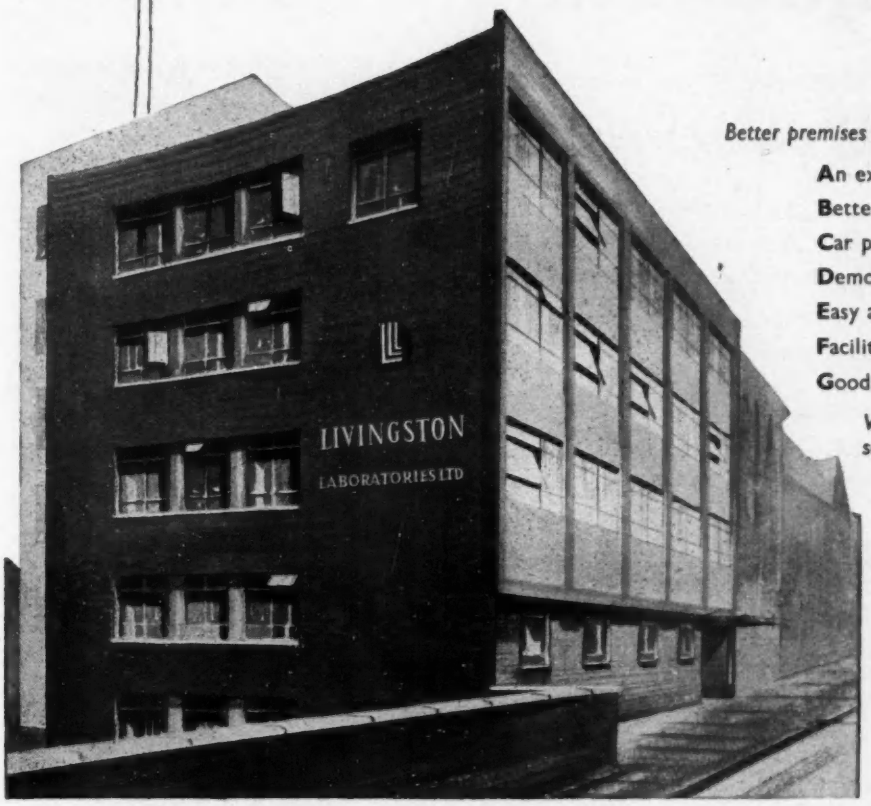

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MAY 30th–JUNE 2nd

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Silicon Junction Rectifiers

Now with these new

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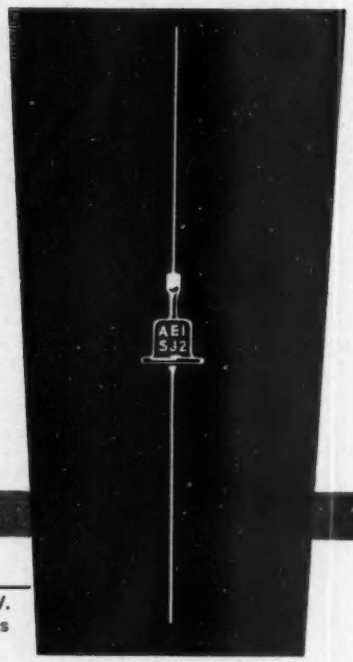
Special protective, non-conductive silicone-enamelled finish over silver plating. Minimizes the possibility of flash-over in dirty environments. (Cooling fin efficiency is unaffected.)

Reduced flange diameter. Wire-ended Form 'F' units 0.4 in. max. Saves space in electronic equipment.



Type SJ Rectifiers are:

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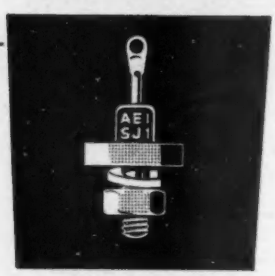
COMPLETELY RELIABLE · FULLY 'TROPICALISED'

Ratings

TYPE	P.I.V. Volts	TYPE	P.I.V. Volts	TYPE	P.I.V. Volts	TYPE	P.I.V. Volts
MAXIMUM CURRENT AT 25°C							
0.7 amp.		1.0 amp.		1.5 amp.*		2.3 amp.*	
SJ051F	50	SJ052F	50	SJ051A	50	SJ052A	50
SJ101F	100	SJ102F	100	SJ101A	100	SJ102A	100
SJ201F	200	SJ202F	200	SJ201A	200	SJ202A	200
SJ301F	300	SJ302F	300	SJ301A	300	SJ302A	300
SJ401F	400	SJ402F	400	SJ401A	400	SJ402A	400
SJ501F	500			SJ501A	500		
SJ601F	600			SJ601A	600		
MAXIMUM JUNCTION TEMPERATURE							
120°C		200°C		120°C		200°C	

* When mounted on suitable cooling fin



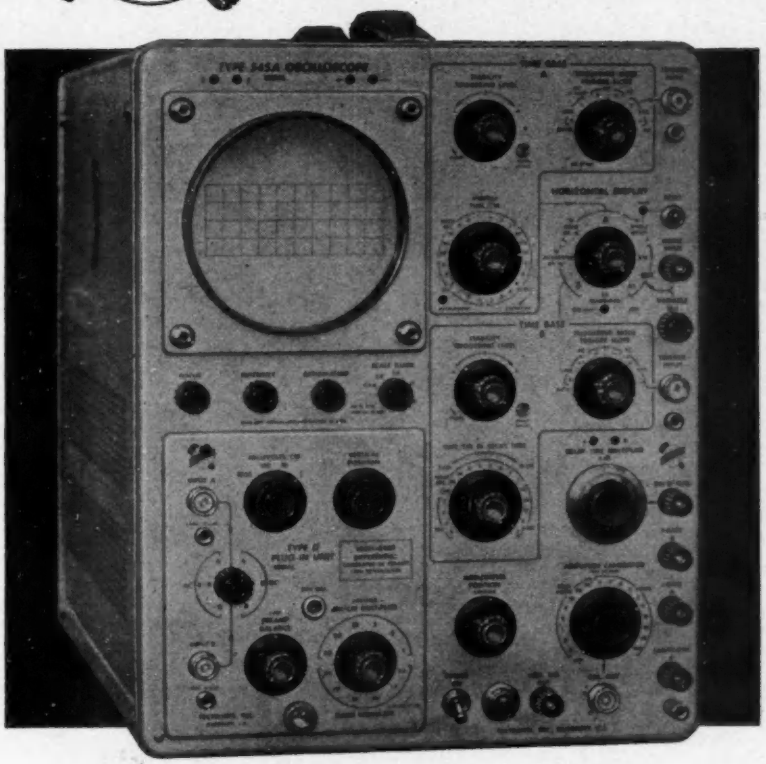
APPLICATIONS

- Rectification • Control
- Magnetic amplifiers
- Brushless alternators
- Power packs • Blocking duties

AEI Associated Electrical Industries Limited

ELECTRONIC APPARATUS DIVISION VALVE AND SEMICONDUCTOR SALES LINCOLN ENGLAND

TEKTRONIX OSCILLOSCOPES



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Time Base A— Calibrated steps 0.1μS/cm to 5 S/cm. Continuously variable 0·1μS/cm to 12 S/cm; also X5 magnifier.
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Versatile Triggering — Jitter introduced by delay and pick off circuitry less than one part in 20,000.
Calibrated delay 1μS to 10 S. Incremental accuracy 0·2%.
£609 *(Delivered U.K.)*
together with a wide range of Plug-in Units from
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515A—Frequency response D.C. to 15 Mc/s.
Vertical sensitivity continuously variable from 50mV/cm to 50V/cm. Calibrated sweeps from 0·2μS/cm to 2 S/cm (0·04μS/cm with X5 Magnifier). Uncalibrated sweeps continuously variable from 0·04μS/cm to 6 S/cm. Versatile triggering.
Two signal inputs with 60 dB separation. **£315** *(Delivered U.K.)*

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PRECISION OSCILLOSCOPES
are now available to
BRITISH USERS
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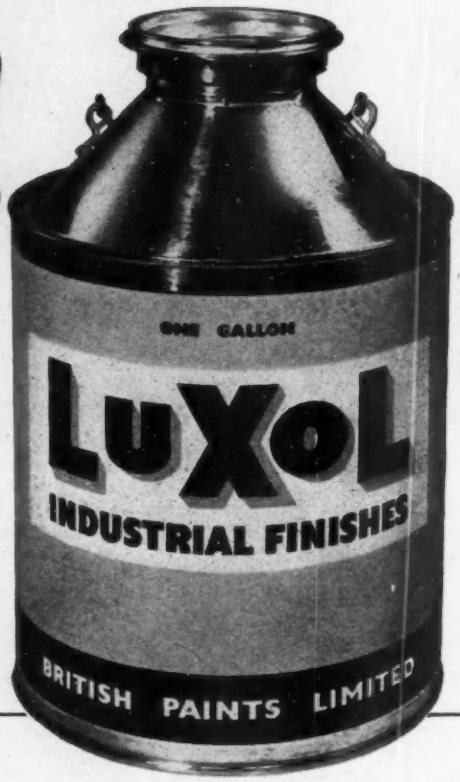

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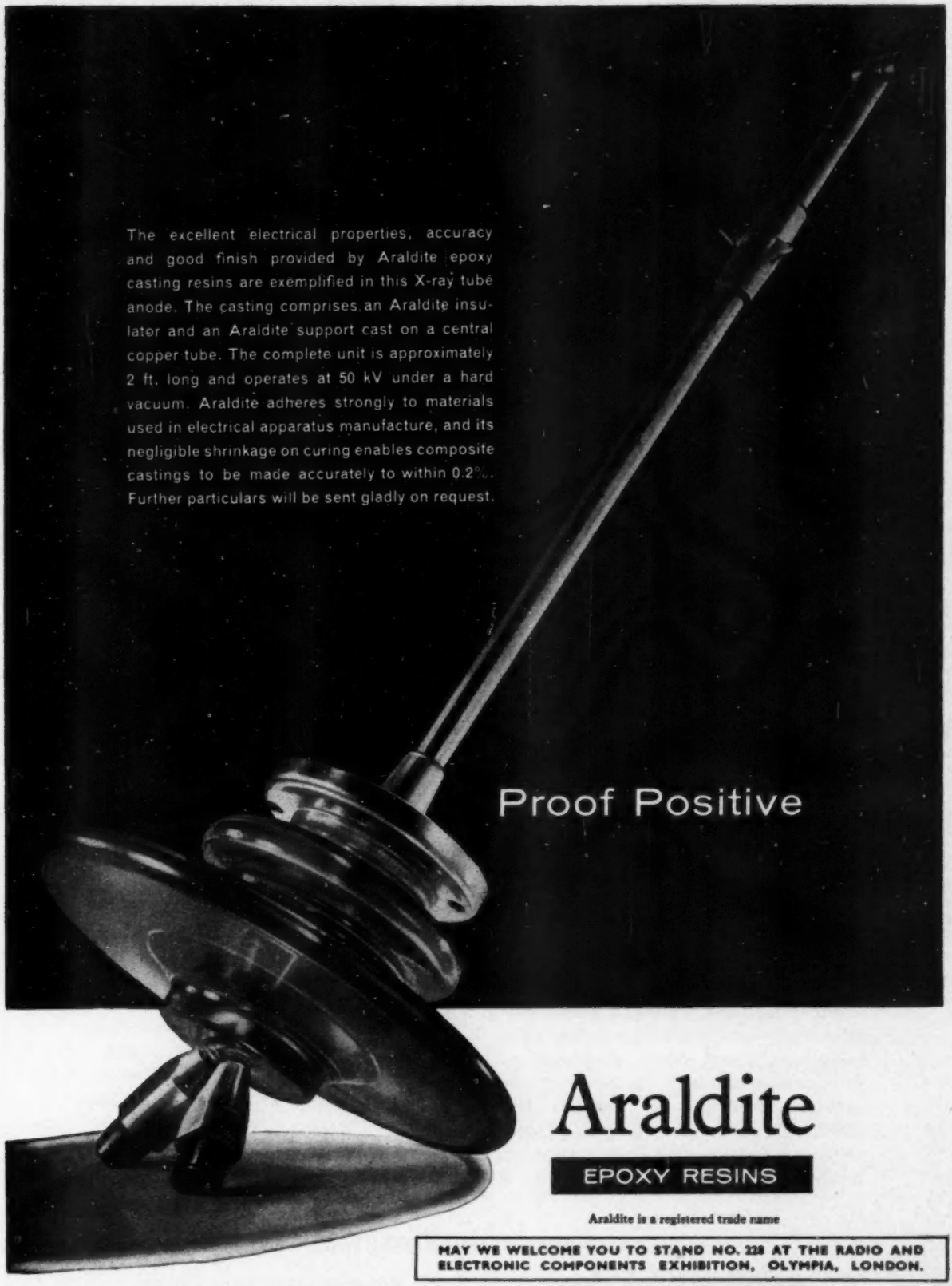
IP34



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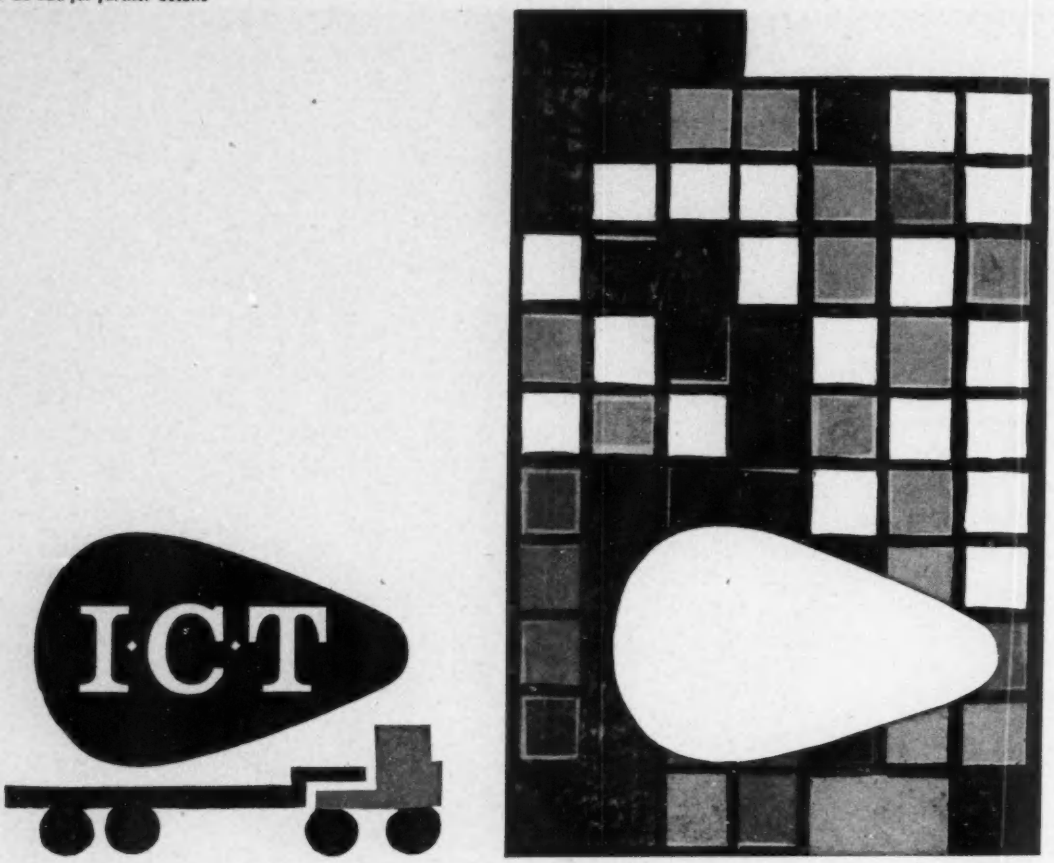
AP 585

EE 33 036 *for further details*



There's an I·C·T computer to fit your business

Shopping for a computer? Then you've a challenging task ahead. For this major investment must pay you major dividends.

Choosing and using a computer effectively and profitably requires imagination and great preparation. This means thinking in terms of the service you'll get as well as the machines you will use. Doing your shopping, in fact, with an organisation having the 'know-how', the resources and the experienced staff to examine your problems creatively, and to propose the data processing system that *fits into your business.*

This is the specialised service that you will get from I·C·T—the largest British firm devoted exclusively to data processing, which has been its business for over fifty years.

I·C·T is at your service. There is an office near you—or write to us now.

I·C·T DATA PROCESSING

International Computers and Tabulators Limited

149 PARK LANE, LONDON, W1. OFFICES THROUGHOUT THE U.K. AND IN 51 COUNTRIES THE WORLD OVER

SILICON TRANSISTORS

for Industry

Now, for the first time, general purpose transistors specifically intended and priced for industrial applications

ACTUAL SIZE

in the JEDEC TO-5 case
for ease of circuit assembly and soldering

β 15-50 ..... 2S701
β 30-90 ..... 2S702

AND NOW HIGH GAIN TYPE β 60-250 .... 2S703

MEDIUM POWER TYPES ALSO AVAILABLE
2S711 · 2S712

Exceptionally low I_{CEO} (I_{CO}'), lower than I_{CBO} for comparable germanium devices.

No derating from −40°C to +50°C —suitable for equipment designed for Arctic AND Tropical climates.

High cut-off frequency (for 2S701 & 2S702 typically 8 Mc/s—for 2S703 16 Mc/s)—one transistor can be specified for all stages of the equipment.

TEXAS INSTRUMENTS
LIMITED
MANTON LANE · BEDFORD · ENGLAND
BEDFORD 67466 · CABLES: TEXINLIM, BEDFORD

RECMF
STAND 303 · GRAND HALL

91/A42

EE 33 038 *for further details*

for 'ULTRA' definition

Bextrene

BC15 has the edge

Clean and clear-cut, the casing of this new 'Ultra' (TR60) transistor radio was injection-moulded by Halex in Bextrene BC-15 moulding powder. The superior flow characteristics of this toughened polystyrene enables highly complex shapes to be moulded with complete accuracy, impeccable definition and fine finish. Dies with slight undercuts can be freely used because BC-15, more than four times stronger than ordinary grades, permits mouldings to be ejected without fracture. It conforms to Type 1 requirements of British Standard 3126, and can be produced in a great variety of translucent and opaque colours. Send for full technical data and make use of the BX Plastics Technical Service Department. They have wide experience in all techniques of plastic moulding.

BX PLASTICS LIMITED The British Xylonite Group, CHINGFORD, LONDON, E.4.

TA 524B

Texas MOLY/G* devices

*Trademark

AID AUTOMATIC ASSEMBLY OF ELECTRONIC EQUIPMENT

AVAILABLE NOW IN PRODUCTION QUANTITIES

1S111 Series
High Power Silicon Rectifiers
400mA · 600V

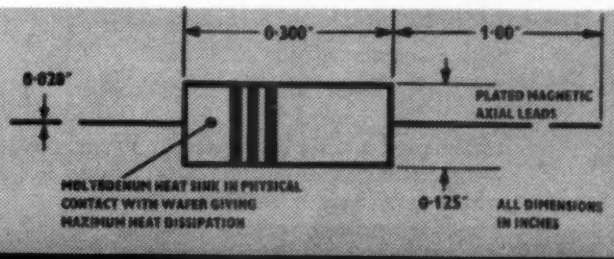
1S120 Series
Silicon Signal Diodes
50mA · 150V

1S914 Series
Diffused Silicon Mesa Computer Diodes
4mμsec · 75mA · 75V

1S7000 Series
Silicon Voltage Reference Diodes
3·3V-15V · 400mV

- *Suitable for automatic assembly on printed circuits because of standard size and shape, and magnetic leads.*
- *Special Texas MOLY/G* molybdenum-to-hard-glass seal gives resistance to severe mechanical shock.*
- *Long leakage path makes the devices particularly suitable for equipment used in industrial conditions and at high altitudes.*
- *Low junction temperatures are maintained by molybdenum heat sinks which give high heat dissipation and therefore high thermal capacity.*
- *Matched coefficients of thermal expansion of molybdenum and hard glass envelope eliminate differential heat strain.*
- *The only range of devices of their kind in mass producton in this country—now.*

HALF THE SIZE OF A ¼W RESISTOR



CV Type Approval covers many of these devices—write for details

Data Sheets and Application Information are available on all TEXAS semiconductor devices, which include:

TEXAS INSTRUMENTS
LIMITED
MANTON LANE · BEDFORD · ENGLAND
BEDFORD 67466 · CABLES: TEXINLIM, BEDFORD

RECMF
STAND 303 · GRAND HALL

91/A34

Superfine Wires by–

B·D·H

Precision resistors and potentiometers must, inevitably, be precise. So must the resistance wires which go into them.

By precise, we don't only mean in the critical matter of size. Superfine wires must match exactly in finish, physical properties and electrical characteristics the requirements of the particular job. These requirements vary widely from one application to the next, and the British Driver-Harris range of superfine wires has been planned to cover them.

Sizes. Starting at .002 in. (0.05 m.m) and working downwards.

Finishes. Bright, oxidised, enamelled, and enamelled and silk covered, for example.

Temper. Annealed or hard.

Nichrome & Nichrome* V.* Nichrome* (65/15 type nickel-chromium-iron) and Nichrome* V (80/20 type nickel-chromium) are the alloys most suitable where a high resistance is necessary and where the change in resistance due to temperature does not hinder satisfactory performance.

Karma.* This is essentially a modified 80/20 nickel-chromium alloy, developed especially for the electronics industry, which combines a high specific resistance with a low temperature coefficient.

Advance.* Wires of this 60/40 copper-nickel alloy have a low temperature coefficient and a fairly high specific resistance —important properties in precision resistors which must have constant resistance over a wide temperature range.

**Reg. Trade Mark*

NICHROME
REGD TRADE MARK

BRITISH DRIVER-HARRIS CO LTD

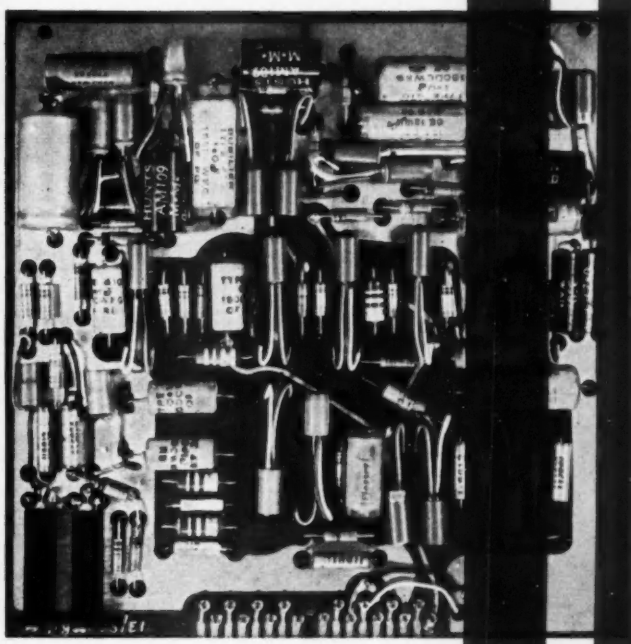
CHEADLE HEATH,
STOCKPORT, CHESHIRE

For further information write for Data Sheet No. 1, a 4-page booklet containing concise technical information.

EE 33 041 *for further details*

DATA*flex*

modular instruments for industrial process control and data handling



OPERATIONAL AMPLIFIER

This Operational Amplifier is built on a 7 inch x 7 inch printed wiring board for easy incorporation into other equipment. Usually it plugs in but for extra reliability it can be wired in.

The Amplifier can be used for differentiating, integrating, linearising, analogue to digital, voltage to digital and frequency to voltage conversion. It is one of the basic circuits in the Dataflex range and is used in a number of Dataflex Units.

Note these features:—

- **Completely transistorised**
- **High gain—10^7 at d.c. reducing to unity at 2 Mc/s**
- **Transistor chopper for drift correction**
- **Extremely low input voltage and current drift**
- **Input noise less than 100 μ V**

Incidentally it costs only £40.

Write now for details of this and other Dataflex Units to:

BENDIX ERICSSON U.K. LTD.

HIGH CHURCH STREET · NEW BASFORD · NOTTINGHAM · Telephone: Nottingham 75115

ER16 *(FORMERLY ERICSSON INSTRUMENT DIVISION)*

EE 33 042 *for further details*

2

Mullard

MULLARD LIMITED *Government and Industrial Valve Division*
Mullard House · Torrington Place · London · WC1 Telephone: LANgham 6633

EE 33 043 *for further details*

millimicroseconds

The 56AVP Photomultiplier is acknowledged to be the most advanced of its kind in the world. The width of the output pulse delivered by the 56AVP is as little as 2 millimicroseconds at half height, and the rise time is of the same duration. Another exceptional characteristic of this most exceptional photomultiplier is a high peak output current of 1A, linear up to 300 mA.

A remarkable range of Photomultipliers

The 56AVP is, in fact, an outstanding member of a distinctly outstanding range—the thirteen Mullard photomultiplier tubes, all of them providing unsurpassable performances, some of them unequalled in the world.

This range covers the spectrum from ultra-violet to near infra-red and three of the tubes incorporate a unique focused dynode system, providing their excellent transit time spread and rise time.

These tubes were introduced only after the most intensive development programme. In particular, the construction, arrangement and mounting of the secondary cathodes have been the subject of exhaustive studies aimed at producing a multiplier system giving a high current gain, minute dark current and minimum variation of electron transit time.

For so many applications

Employment in scintillation counting and gamma spectroscopy are but two of a very broad range of applications in which these tubes are used.

There is so much to be said . . .

about the 56AVP and the other twelve tubes in this range that you can gather all the necessary information only by studying the Mullard data sheets which will gladly be sent on request. Write now for these and for any further details concerning the Mullard photomultipliers and their applications. Here are brief details of the complete range

51UVP Eleven stage tube with 32 mm diameter photocathode and quartz end window to give sensitivity to ultra-violet.

52AVP Ten stage tube of 25 mm outside diameter and with 20 mm diameter photocathode.

53AVP Eleven stage tube with 44 mm diameter photocathode for use in gamma spectroscopy.

53UVP As 53AVP but with quartz end window to give sensitivity to ultra-violet.

54AVP Eleven stage tube with 111 mm diameter photocathode for flying spot scanners.

56AVP Fourteen stage tube with focused dynode structure giving rise time and transit time spreads of 2×10^{-9} s. 42 mm diameter photocathode.

56UVP As 56AVP but with quartz end window.

57AVP Eleven stage tube with large photocathode 200 mm in diameter.

58AVP Fourteen stage tube with 110 mm diameter photocathode. This tube has a tetrode input system, giving spreads in transit time over the photocathode of 10^{-9} s.

150AVP General purpose ten stage tube with 32 mm diameter photocathode.

150CVP As 150AVP but with a photocathode sensitive to infra-red radiation up to 1.2 μ.

153AVP Eleven stage tube for use with scintillation crystals giving a resolution of less than 8% with Cs^{137}.

MVTD404

THE ONLY FULLY TRANSISTORISED

HIGH VOLTAGE POWER SUPPLY UNITS

- Fully Transistorised *
- Higher Efficiency *
- Low Heat Dissipation *
- Fully Protected Against Overload and Short Circuit *
- 2 Year Guarantee *
- Reduced Size and Weight *
- Low Price *
- Increased Reliability *
- Robust and Shock Resistant *
- Incorporating Mains and Output Fuses *
- C Core Transformers *

Illustrated is a 500mA unit

These fully transistorised units have been designed to meet the demand for a more reliable power supply for electronic equipment. The elimination of valves, neons, etc. enabled the size and weight of the unit to be substantially reduced. For example the 500mA model measures only 9½" x 6½" x 8½" and weighs no more than 17¼ lb.

Our Technical Department will be pleased to offer advice on any power supply requirement and to demonstrate the new unit on your own premises.

Type No.	Output Voltage	Output Current	Output Impedance in 600 KC/S Band Width	RMS Ripple Less than	Stability Factor	Size & Weight	Price
PS150/1 PS200/1 PS250/1 PS300/1	150 200 250 300	100mA	.5 ohm	1mV	400:1	9½" x 6½" x 6½" 13 lb	£33.0.0
PS150/2 PS200/2 PS250/2 PS300/2	150 200 250 300	200mA	.5 ohm	1mV	400:1	9½" x 6½" x 6½" 14½ lb	£44.0.0
PS150/3 PS200/3 PS250/3 PS300/3	150 200 250 300	300mA	.5 ohm	1mV	400:1	9½" x 6½" x 6½" 16 lb	£54.0.0
PS150/4 PS200/4 PS250/4 PS300/4	150 200 250 300	500mA	.5 ohm	1mV	400:1	9½" x 6½" x 6½" 17½ lb	£71.0.0

Mains Variation ± 7½ at any load
All units have two 6.3V 1 amp. heater windings, one with centre-tap

INTERNATIONAL ELECTRONICS LTD

132-135 *Sloane Street, London, S.W.1. Telephone: SLOane 1366*

Research & Development Plant:
Electronic Installations & Equipment Ltd., Haslingden, Lancs. Telephone: Rossendale 1353

* *Provisional Patent No.* 9670/60

ENTIRELY NEW STABILISED

LOW VOLTAGE POWER SUPPLY UNITS

Illustrated are 2A and 5A units

- Low Price *
- Overload and Short Circuit Protection *
- Increased Reliability *
- Reduced Size and Weight *
- Robust and Shock Resistant *
- Incorporating Mains and Output Fuses *
- Fully Transistorised *
- 2 Year Guarantee *
- C Core Transformers *

The design of these units obviates the necessity for using the large numbers of power transistors commonly found in conventional power supply units; consequently, these units are considerably smaller and much more reliable.

Complete protection is afforded by both mains and output fuses.

These units are the first of a range of low voltage power supplies incorporating entirely new principles which, coupled with improved production techniques, enable them to be offered at highly competitive prices.

Our Technical Department will be pleased to offer advice on any power supply requirement and to demonstrate the new units on your own premises.

Type No.	Output Voltage	Output Current	0/0 Output Resistance less than	Output Impedance up to 100 K/C less than	Ripple R.M.S. less than	Stability Factor better than	Size	Price
[illegible]	5V—50V (± 5% variable)	2 amp	.025 ohm	.25 ohm	1mV	1000:1	5½" x 3" x 6½"	£48.0.0
[illegible]	25V—50V (± 5% variable)	2 amp	.025 ohm	.25 ohm	1mV	1000:1	5½" x 3" x 6½"	£60.0.0
[illegible]	5V—25V (± 5% variable)	5 amp	.025 ohm	.25 ohm	1mV	1000:1	5½" x 5½" x 6½"	£70.0.0
[illegible]	12V—50V (± 5% variable)	5 amp	.025 ohm	.25 ohm	1mV	1000:1	5½" x 5½" x 6½"	£80.0.0
[illegible]	5V—12V (± 5% variable)	10 amp	.025 ohm	.25 ohm	1mV	1000:1	14" x 8" x 8½"	£85.0.0
[illegible]	12V—25V (± 5% variable)	10 amp	.025 ohm	.25 ohm	1mV	1000:1	10" x 8" x 8"	£105.0.0

Mains Variation ± 5% at any load.
The output voltage is pre-set to any specified value within the above range.

IE

INTERNATIONAL ELECTRONICS LTD

132-135 Sloane Street, London, S.W.1. Telephone: SLOane 1366

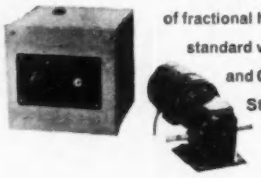
Research & Development Plant:
Electronic Installations & Equipment Ltd.,
Huntingdon, Lancs.
Telephone: Rossendale 1328

* Provisional Patent No. 8328[illegible]

CONTROL FOR INDUSTRY

RUGELEY · STAFFS

Adjustable Speed Drives
Series FMC. 1.

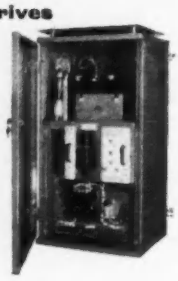


Provide fingertip speed control of fractional h.p. motor. In two standard variations for 0·05 and 0·1 h.p. motors.—Standard Products Division.

LANCASHIRE DYNAMO ELECTRONIC PRODUCTS LIMITED

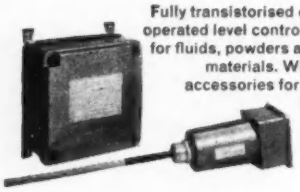
RUGELEY · STAFFS

Adjustable Speed Drives
Series BMC.1 & 2.



In two ratings up to 3·5 h.p. and up to 15 h.p., both having a good regulation and 10:1 stepless speed range.—Standard Products Division.

Level Control
Series TLC.1.

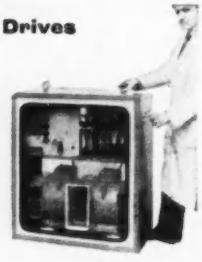


Fully transistorised capacitance operated level control equipment for fluids, powders and granular materials. Wide range of accessories for operational flexibility.—Standard Products Division.

LANCASHIRE DYNAMO ELECTRONIC PRODUCTS LIMITED

RUGELEY · STAFFS

'Transidyne' Adjustable Speed Drives



Unique transistor controlled Ward-Leonard drives available in 'packaged' construction for motors up to 20 h.p. and in pillar type up to 1000 h.p.—Standard Products Division.

As Britain's leading manufacturers of industrial electronic control equipment, Lancashire Dynamo Electronic Products Ltd. offer a range of products in this field which is second to none. This equipment, developed, designed and produced by a specialist organisation, finds application in almost every branch of industry.

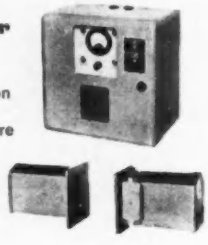
For full details of any of the products, write for leaflet GA2.

Metal Industries Group

LANCASHIRE DYNAMO ELECTRONIC PRODUCTS LIMITED

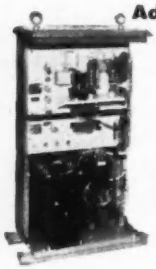
RUGELEY · STAFFS

Smoke Alarm and Densitometer
Series SME.2.



For monitoring the emission of smoke from factory and other smokestacks to ensure compliance with the Clean Air Act. Independently certified by the British Standards Institution.—Standard Products Division.

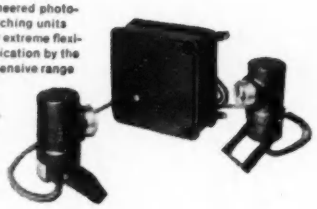
Adjustable Speed Drives



Grid controlled thyratron rectifier drives with up to 60:1 stepless speed range with close regulation. In ratings up to 30 h.p.—Standard Products Division.

Photoelectric Switching Units
Series EPU.3.

Highly engineered photo-electric switching units designed for extreme flexibility of application by the use of an extensive range of electrical and optical accessories. — Standard Products Division.



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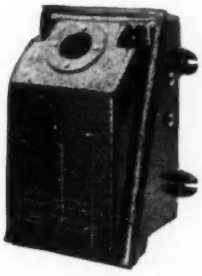
Position Controls

Automatic control in medicine as well as industry —here a positional and movement control for cobalt bomb radiation therapy unit. —Systems Division.

LANCASHIRE DYNAMO ELECTRONIC PRODUCTS LIMITED

Automatic Lighting Control
Series ALC.3.

Switches artificial lighting in factories, yards and streets from daylight level. Fully weather-proofed, compact, needs no adjustment through the year. — Standard Products Division.



RUGELEY · STAFFS

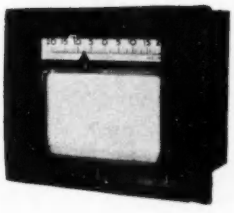
Comprehensive packaged resistance Welding Control Equipment
Series CRW.1.

Extremely versatile range suitable for all types of resistance welding control. Basic cubicle accommodates alternative sub-units providing non-synchronous or synchronous timing, stepless heat control, automatic current regulation, etc. —Resistance Welding Control Division.

LANCASHIRE DYNAMO ELECTRONIC PRODUCTS LIMITED

Strip Chart Recorder/Indicator/ Controller
Series SCR.3.

Rebalance potentio-meter type with 10" wide chart provides high performance at low cost. — Instrumentation Division.

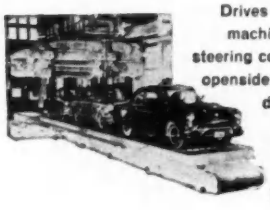


RUGELEY · STAFFS

Manufacturers of the world's widest range of industrial electronic control equipment

LANCASHIRE DYNAMO ELECTRONIC PRODUCTS LIMITED

Machine Tool Feed Drives



Drives for all motions on machine tools including steering controls. Here large openside plano-miller table drive has very wide speed range and automatic cutter load control.— Systems Division.

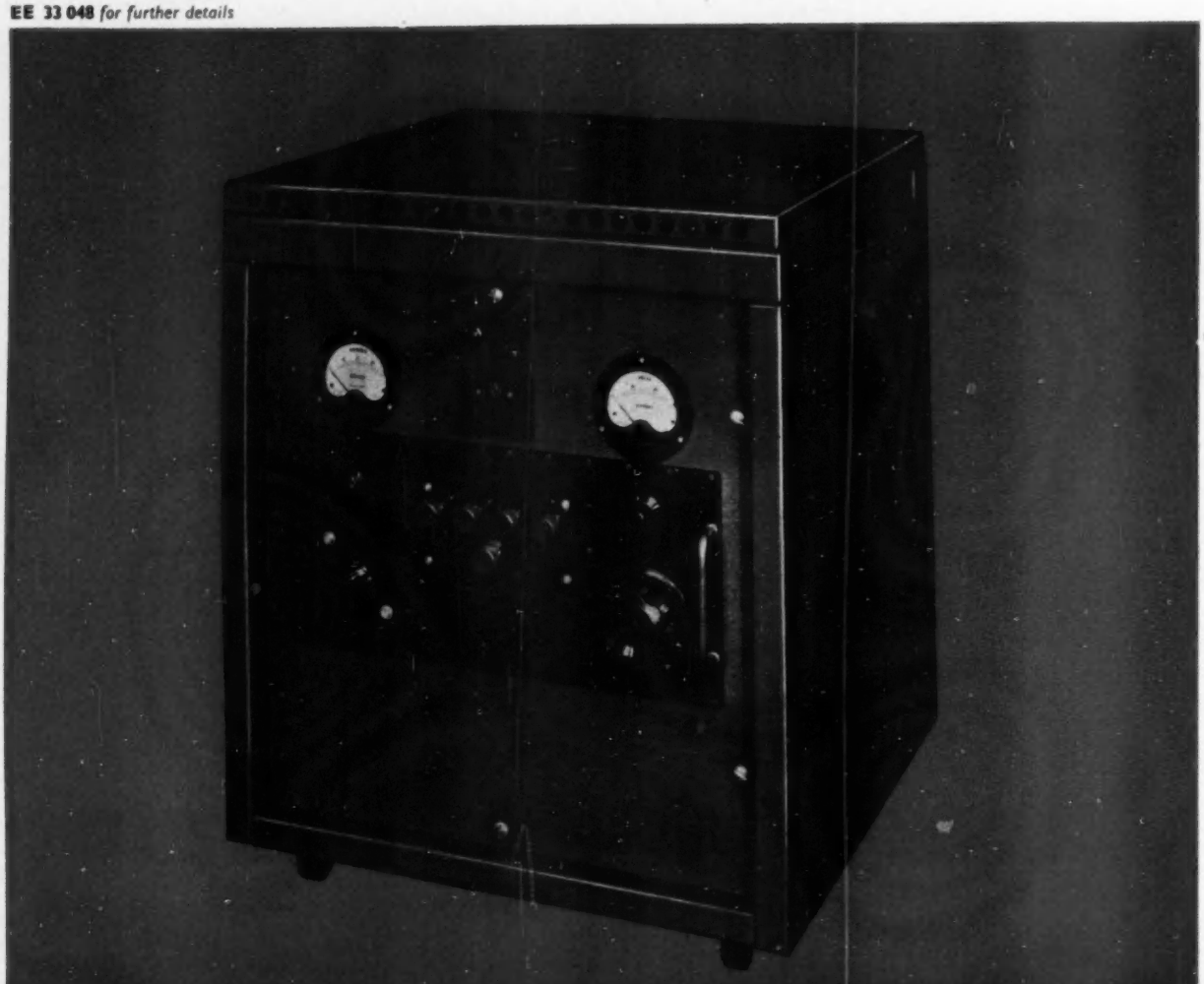
RUGELEY · STAFFS

Process Timer
Series PCT.1.

For precision timing at economic price. Six time ranges 0·1 to 500 seconds and many mechanical variations for application flexibility. —Standard Products Division.

G.A.1

EE 33 048 *for further details*



SERVOMEX

Stabilised D.C. Power Supplies

A range of relatively high power d.c. stabilisers capable of standing heavy overloads and suitable for continuous industrial use by unskilled people, and even students. Although the correcting mechanism is mechanical, the response time is shorter than many magnetic stabilisers of similar power. Small errors are fully corrected in 100 milliseconds.

The range comprises :

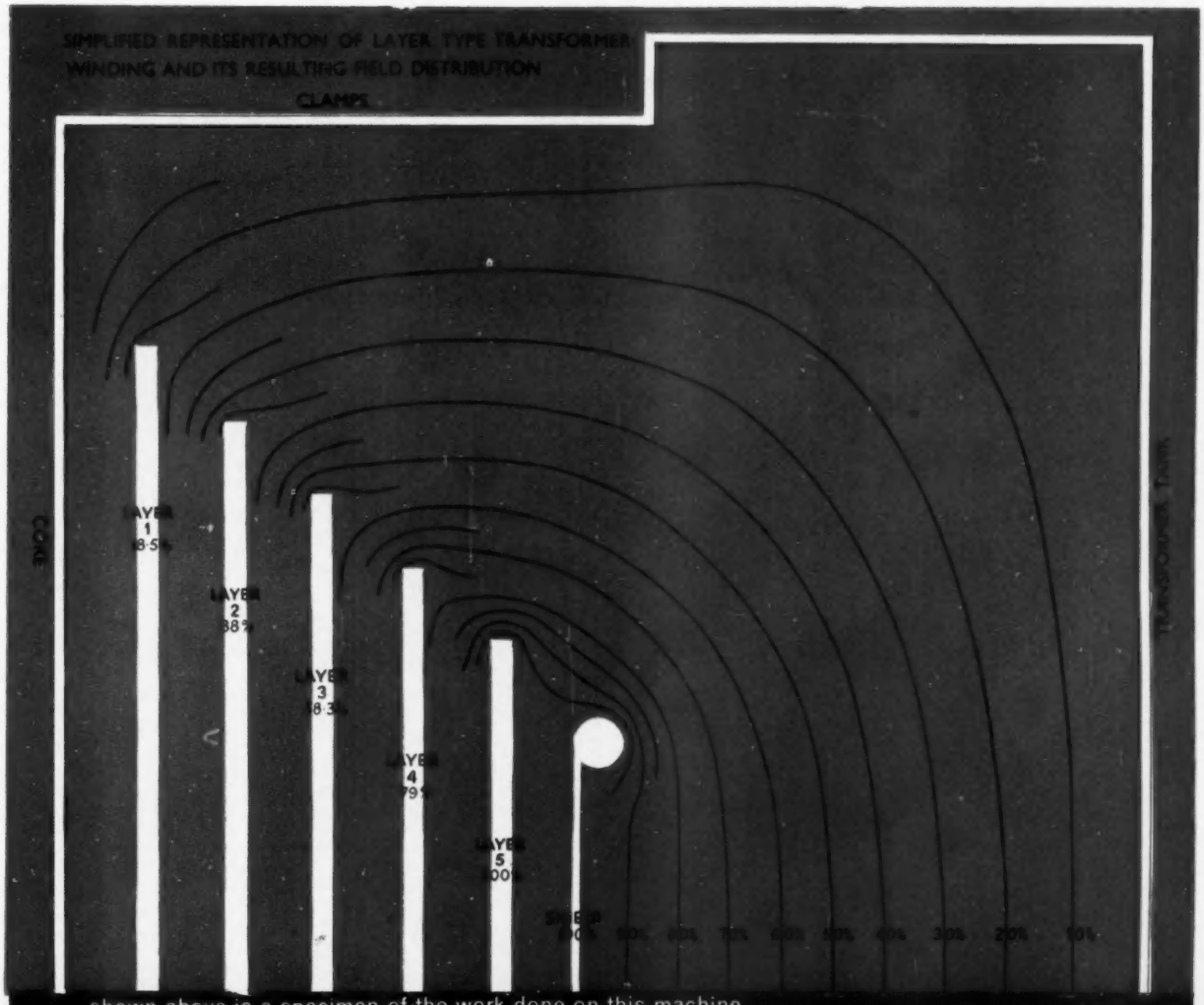
DC.60 24 – 240 volts 0-5 amps
DC.59 12 –120 volts 0 to 10 amps

- Ripple at full load, about 0.1% R.M.S.
- Stability ± 0.3% of the maximum voltage of the instrument.

DC.58 6 – 60 volts 0 to 20 amps
DC.56 3 – 30 volts 0 to 40 amps

- The workmanship and the bulk of the components are to military specifications, robust, easily serviced by non-specialists, and suitable for tropical climates.

Servomex Controls Ltd., Crowborough, Sussex. Crowborough 1247



shown above is a specimen of the work done on this machine.

SERVOMEX
New Field Plotter FP92

This novel device can be applied to field problems in many branches of science and engineering; in fact, wherever the inverse square law applies. The interesting example above shows lines of electric equipotential in the insulation of a transformer. Observe that the electric stress has been magnified near the windings, because the equipotentials at these points have been plotted every 5% instead of every 10% as in most of the field. The price is £33, delivery from stock.

This field plot was supplied by the courtesy of the Transformer Development Department of Ferranti Limited, Hollinwood.

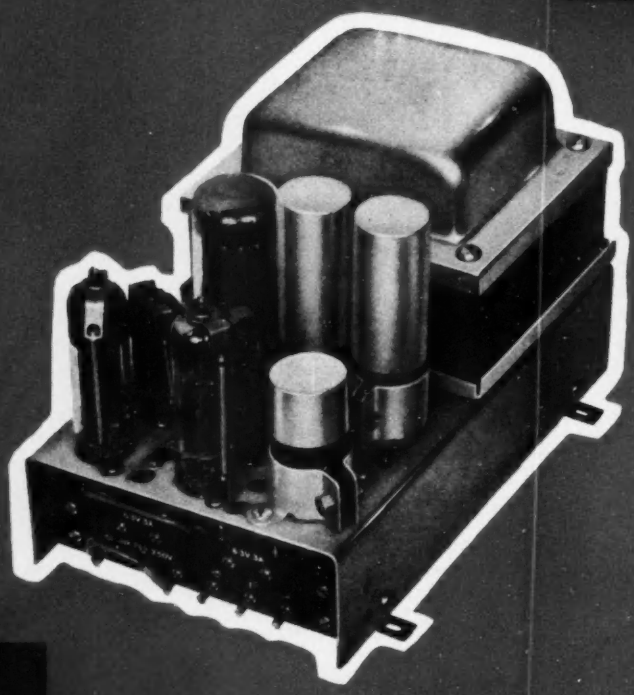
Servomex Controls Ltd., Crowborough, Sussex. Crowborough 1247

EE 33 050 *for further details*

Todays finest value for only £20

STABILISED POWER SUB-UNIT

MODEL 4931



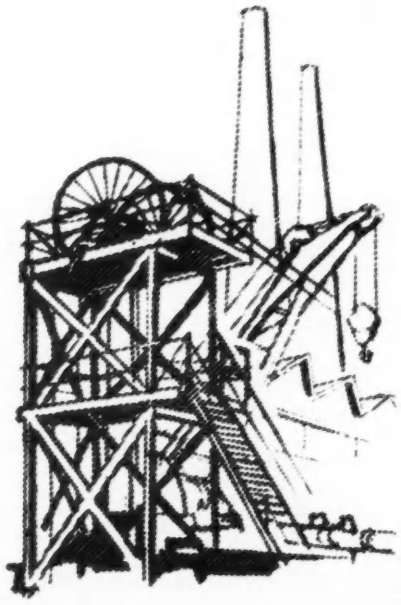
This very small unit, supplying **250** or **300 V.D.C.** at **150 mA.** max. is ideal for building into your equipment. At this price, with a stability of ±0·1% it is no longer worthwhile designing your own power pack.
Write for further details of this unit and its companion model 4964 providing 150V. or 200V. at 150 mA.

A·P·T

ELECTRONIC INDUSTRIES LIMITED

CHERTSEY ROAD
BYFLEET, SURREY

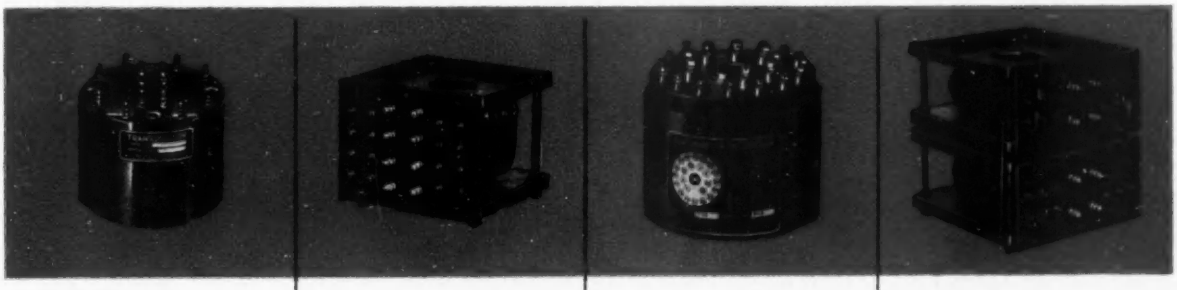
BYFLEET 41131/2/3/4 PABX
GRAMS: APTRAN, BYFLEET



wherever
speed, frequency or
voltage is controlled
you'll find

Sanders

TRANSDUCTOR AND MAGNETIC AMPLIFIER SYSTEMS



Type 1000

Encapsulated transductors meeting Climatic Classification 40/70 H1. They have passed the tests for Inter-Service Type Approval as specified in RCS (Prov) 217, and are used extensively in Service equipment.

Supply Freq.	*D.C. Output*
50 c/s	From 0·005W to 11W
400 c/s	From 1W to 145W

Type 2000

Open-type transductors suitable for use in industrial applications requiring Climatic Classification 40/70 H2. Many of these transductors are in use in steel works, coal mines and similar situations where robustness and reliability are of prime importance.

Supply Freq.	*D.C. Output*
50 c/s	From 50W to 500W
400 c/s	From 500W to 4000W

Type 3000

Transductors use toroidal cores, the whole assembly being encapsulated in an epoxy resin to make a component satisfying the requirements of Climatic Classification 40/70 H1. This range is Admiralty Approved and is used extensively in Service equipment.

Supply Freq.	*D.C. Output*
50 c/s	From 50W to 250W
400 c/s	From 500W to 2000W

Type 4000

In the 4000 range the transductors are of the same high quality and finish as the 2000 range, but the construction is such that they can be supplied as either 1-, 2-, or 3-element assemblies. Climatic Classification 40/70 H2.

Supply Freq.	*D.C. Output*
50 c/s	From 50W to 1000W
400 c/s	From 500W to 8000W

The Sanders range of high performance transductors is ideally suitable for use in automatic control systems and applications where size, weight and quality are important. A comprehensive selection of transductors exists for operation from both 50 c/s and 400 c/s supplies. The advantage of being able to obtain a standard type of transductor with known characteristics enables them to be offered at competitive cost and with a short delivery period. In addition to this standard range, a large selection of transductors is produced using the same high quality construction, but having different windings to suit individual requirements.

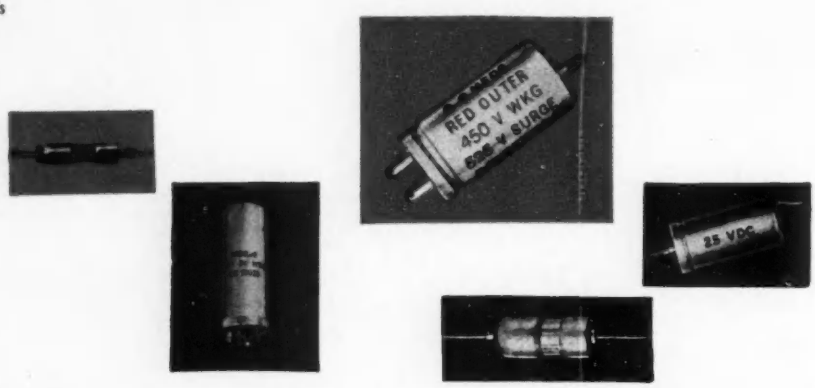
This is one of a series on instruments and components by

THE Sanders GROUP OF COMPANIES

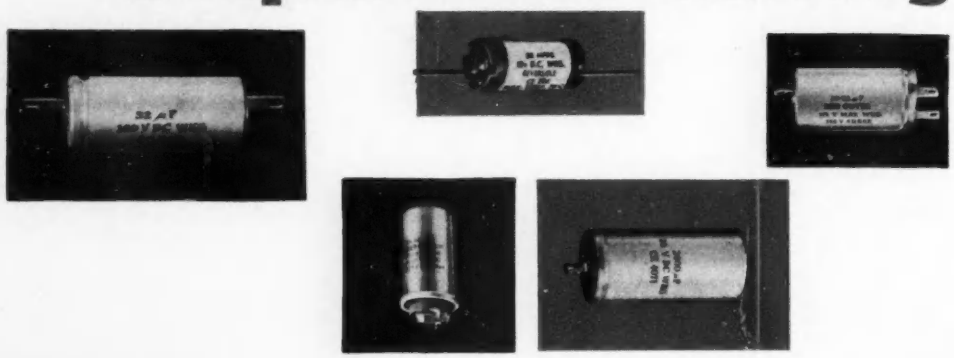
W. H. SANDERS (ELECTRONICS) LTD

GUNNELS WOOD ROAD · STEVENAGE · HERTS
Telephone: Stevenage 961. Telex 82159 Sanders Stev.

EE 33 052 *for further details*



Capacitorability



In the design and production of thoroughly reliable electrolytic capacitors, Plessey have for years held a commanding lead. To every new demand made by rapid developments in radio, television and electronic equipment Plessey can respond by bringing to bear unrivalled experience, tremendous resources and highly skilled staff. Such is the care taken to obtain impeccable standards of quality and performance, that virtually clinical conditions of manufacture are maintained in the superbly equipped laboratories and workshops. These same exacting standards are imposed throughout the comprehensive range of capacitors produced by Plessey.

Whatever the requirement Plessey **provides the finest component**

THE PLESSEY COMPANY LIMITED

Capacitors & Resistors Division: Kembrey Street · Swindon · Wiltshire · Tel: Swindon 6211

Overseas Sales Organisation:

PLESSEY INTERNATIONAL LIMITED · ILFORD · ESSEX · ENGLAND

Telephone: Ilford 3040 · Overseas Telegrams: Plessinter Telex Ilford

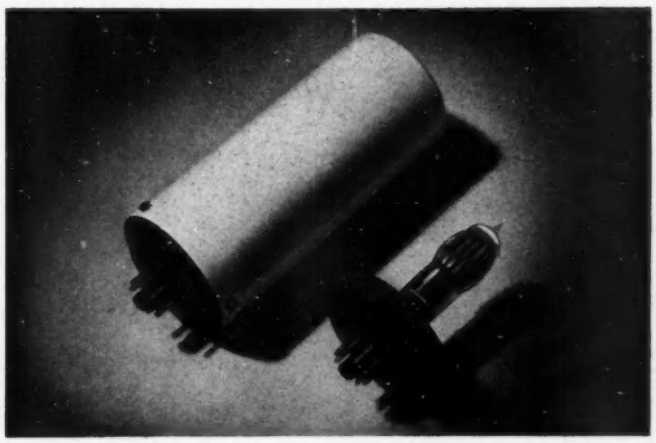
CR9

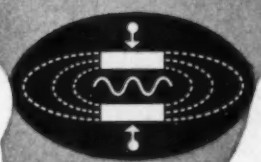
Quartz Crystal Ovens

STABLE TEMPERATURE ENSURING MAXIMUM FREQUENCY STABILITY

Switching differential 0·0014°C.
No thermostat
No thermometer switch

Orthodox crystal ovens, using thermostats or thermometer switches, are available for applications where wider temperature variations are acceptable.





This symbol has been adopted by the Marconi Specialized Components Group. The Marconi Company undertakes the design and manufacture of specialized components only when no suitable alternative is available; and in almost every case, Marconi specialized components are designed to more exacting standards and built to closer tolerances than any similar components. A preliminary catalogue is available, listing ferrite isolators and circulators, coaxial connectors, attenuators, terminations and switches; waveguide filters terminations, and bends; crystal filters and ovens.

MARCONI

SPECIALIZED RADIO COMPONENTS

Write for details of crystal ovens and other specialized components in the Marconi range, and address your enquiries to:

SPECIALIZED COMPONENTS GROUP

MARCONI'S WIRELESS TELEGRAPH COMPANY LTD.,
CHELMSFORD, ESSEX, ENGLAND

EE 33 054 *for further details*

G.E.C.

PLASTIC FILM CAPACITORS

5pF–2μF

On display at R.E.C.M.F. Exhibition STAND 216

These components are pre-eminent in the field of plastic film capacitors. Advanced manufacturing techniques supported by the Company's vast resources for research and development combine to produce a wide range of high-quality capacitors based on either polystyrene or polyester dielectric in a film and foil construction, at reasonable cost. This construction ensures maximum reliability.

The basic characteristics of the capacitors are detailed in the table below:

CHARACTERISTIC	POLYSTYRENE CAPACITORS		POLYESTER CAPACITORS	
	Type PF	Type A597	Type PFT	Type A596
Overall Range	5pF–510,000pF	150pF–510,000pF	0·001μF–2μF	0·05μF–2μF
Working Voltages	125–2,000 D.C. 750–2,000 A.C.	125 350 750 2,000	150 250 350 500	150
Insulance	10^6M Ω	10^6M Ω	20,000MΩ /μF or 50,000MΩ whichever is the less	20,000MΩ /μF or 50,000MΩ whichever is the less
Working Temperature Range	−40°C to +70°C derate stability at +70°C to +85°C	−40°C to +70°C	−40°C to +100°C derate voltage at +85°C	−40°C to +100°C derate voltage at +85°C
Power Factor	≤·0005	≤·0005	≤·007	≤·007
Temperature Coefficient	-120×10^{-6} per °C nom.	$-130\pm15\times10^{-6}$ per °C	$+200\times10^{-6}$ per °C nom.	$+200\times10^{-6}$ per °C nom.
Capacitance Stability Temperate Tropical	≈0·25% †	≈0·05% *	≈0·5% <5% after H2	≈0·5% 5%*
Test Voltage	3× wkg.	3× wkg.	2× wkg.	2× wkg.

*Rated RCS11 H1 †Requires sealing for tropical conditions

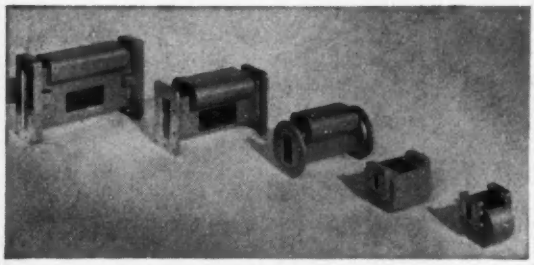
For further information please write to:

SALFORD ELECTRICAL INSTRUMENTS LIMITED

MAGNET HOUSE · KINGSWAY · LONDON WC2 Temple Bar 4666/9

Smee's GEC 84

Ferrite Isolators

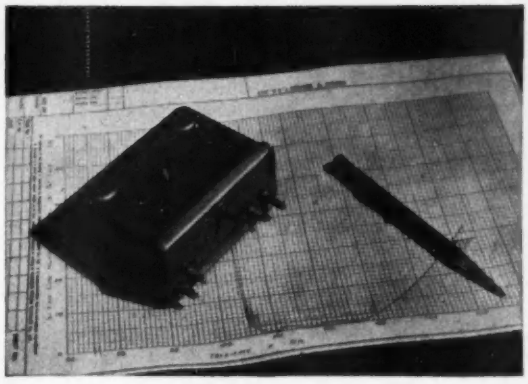


Existing Marconi designs cover most of the frequencies from 1.8 Kmc/s to 10 Kmc/s, and enable the following performance characteristics to be obtained :
Reverse losses of 45 dB or greater VSWRs 1.03.
Forward losses of 0.5 dB or less.
A wide range of ferrite devices, including circulators, is available; if your requirements fall outside our existing range we shall be pleased to consider a design to suit you.

50 ohm Coaxial Connectors

Designed to combine low VSWR with positive mechanical connection at 5000 mc/s, this connector is unique in its use for laboratory measurements and for any application calling for a stable and reliable match. Alternative arrangements are available for flexible cables or panel mounting use. The connectors are normally female but can be converted to male by the simple addition of a locating ring and connecting pin. The design incorporates a sealing ring for waterproofing the connecting joint.

Miniature Crystal Filters



Crystal filters operating at 100 kc/s with bandpass characteristics.
Pairs of upper and lower sideband selection filters for SSB applications.
IF filters at 455 kc/s.
Marconi's are constantly engaged in the development of new crystal filter techniques, and it is impossible to specify the large number of filter designs available. The Company's unique experience in this field enables us to offer advice and technical assistance with filter problems of any kind.

MARCONI

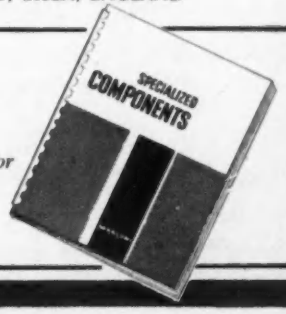
SPECIALIZED RADIO COMPONENTS

Write for details of crystal filters and other specialized components to :

SPECIALIZED COMPONENTS GROUP

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED,
CHELMSFORD, ESSEX, ENGLAND

A preliminary catalogue is available listing specialized components for immediate delivery.



GD626

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D.E.F. 5011 and many other government specifications call for the use of vibration test equipment. Fatigue and resonance search tests are the principal applications but there are several more. In fact, vibration equipment is a design and test facility which is rapidly gaining in scope and importance throughout industry. But for all that, the techniques are still comparatively new and, not unreasonably, present unfamiliar problems to many manufacturers.

We specialise in both the manufacture of such equipment and the technology of its applications. Our range is the most complete in Europe.

If you can't meet D.E.F. 5011 or other government specifications requiring the use of vibration test equipment. Or if you want to be better equipped to do so ... **meet us.**

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the vibration specialists

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EE 33 057 *for further details*

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The range of vapour cooled power triodes by the **English Electric Valve Company Limited** now comprises five standard production types, for r.f. heating and telecommunications equipments, with anode dissipations from 10 to 50 kW.

Vapour cooling, under certain operational conditions, offers positive advantages over other available forms of cooling.

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- ★ **Can be operated where water is scarce.**
- ★ **Ensures completely silent operation.**

Abridged data are given here. For full information on these vapour cooled valves and their water and air cooled variants please write to the address below.

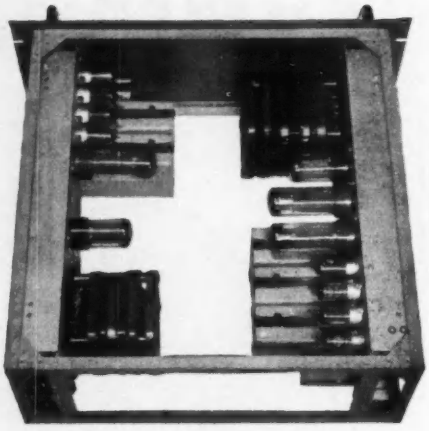
E.E.V. Type	Frequency (Mc/s)	Anode Voltage (kV)	Anode Dissipation (kW)	Output Power (kW)
BY189	20	12	35	82
BY194	5	15	50	159
BY1102	50	12	25	53
BY1121	50	10	18	50
BY1122	5	12	10	29

ENGLISH ELECTRIC VALVE COMPANY LTD.

Chelmsford, England. Telephone: Chelmsford 3491 | AGENTS THROUGHOUT THE WORLD.

AP 168

regulated - well ventilated - power supplies



Improved Brandenburg design, with wide centre ventilation and easier access to all components. Two of model V300/200 mounted in one suitable frame measuring 17½" × 17½" × 7"d. This shows one of many methods of mounting these units

All model voltage stabilized.

polarity reversible
effective resistance 0·1 ohm
stability against + or − 10% mains change: 0·02%
ripple less than 2mV
input 200/250 volts, 50 cycles.
output a.c. 100 and 200 mA models: 4×6·3V, 1·5A. 350 and 500 mA models: 2×6·3V, 5A. All can be paralleled
dimensions 100 and 200 mA models: 15¾" × 5¾" × 6¾" high. 350 mA models: 15¾" × 7½" × 7½" high. 500 mA models: two chassis, each 15¾" × 5¾" × 6¾" high. Flanged open chassis, with frames available for converting all models to front panel mounting

All prices quoted are for U.K. only—ex-works

200-350 V.		200-350 V.	
100 m/A.	£37 10 0	1 Amp.	£140 0 0
200 m/A.	£48 10 0	2 Amp.	£230 0 0
350 m/A.	£64 0 0		
500 m/A.	£80 0 0	complete with 19" front panel and assembly	

Models below 200 volts can be supplied to order.

new current-stabilized models

type C300

input 200/250 volts, 50 cycles
output current 50-300 m/A, continuously variable
output voltage 500 volts, maximum
stability better than 0·1% for + or − 7% mains variation
drift less than 0·5% for 30 minutes

enquiries are invited for similar specifications

Brochure of Brandenburg voltage-stabilized range also available

---

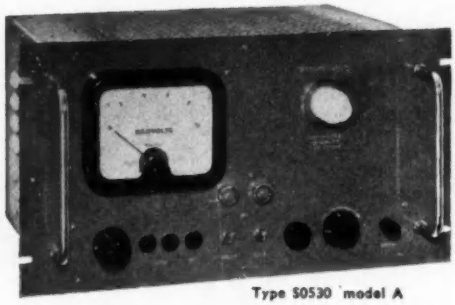
BRANDENBURG LIMITED

139 Sanderstead Road, South Croydon, Surrey. SANderstead 3555/6

Export enquiries to: Applied Research (Instruments) Ltd. Emefco House, Reigate, Surrey, England

high voltage regulated power supplies —standard models up to 100 kV.

5, 10, 20 and 30 kilovolt regulated supply



Type S0530 model A

All prices quoted are for U.K. only

Type S0530

output 1 to 10 kV at 2mA. Model A
2 to 20 kV at 1 mA. Model B
3 to 30 kV at ½ mA. Model C
500 V to 5 kV at 2 mA. Model D

input 200/250 volts, 50 cycles

polarity positive or negative grounded available

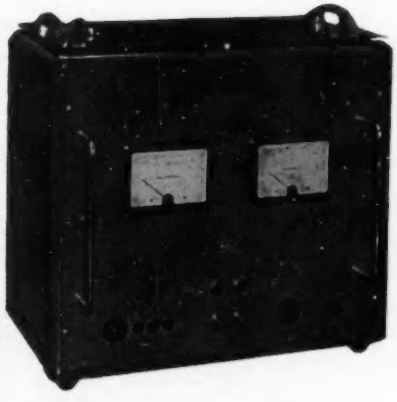
regulation against full load: better than 0.5%
Against mains variations of plus or minus 7%, better than 1%

- 5" Ernest Turner movement
- current metering jack
- standard 19" x 10½" P.O. panel
- for rack mounting or bench use

£135 ex-works

Models A, B and C can be supplied with reversible output polarity at £165

50 kilovolt regulated supply



Type MR50R

Type MR50R

output 5 kV to 50 kV at 1 mA

input 200/250 volts

polarity reversible

regulation against full load: better than 1%
Against mains variations: +5%,—5%, better than 1%

dimensions W: 24" H:23" D: 15"

£245 ex-works

100 kilovolt regulated power supply

Type MR100R—3 models

output current 0.5 mA. Model MR100R/500
1 mA. Model MR100R/1

output voltage 10 to 100 kilovolts, continuously variable

polarity reversible

ripple 0.1%

regulation no load to full load: better than 1%. Against mains variations of plus or minus 7%, better than 1%

input 200/250 volts, 50 cycles

metering output voltage and current metered

Brochure on request : for further specifications of this Brandenburg range of standard high voltage equipment, please write for brochure.

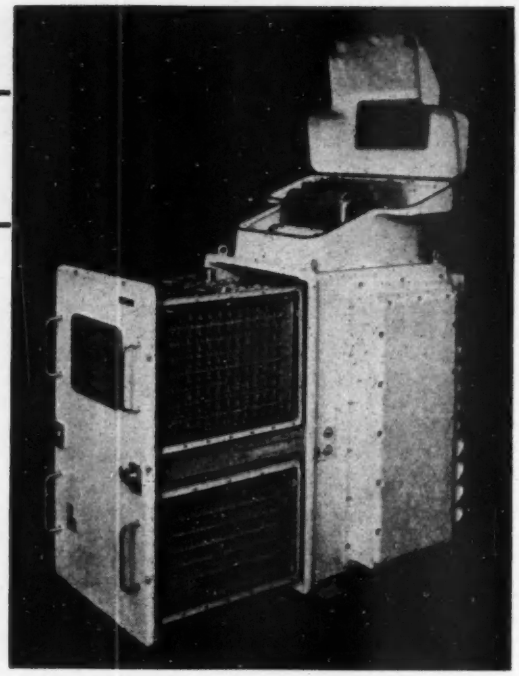
BRANDENBURG LIMITED

139 Sanderstead Road, South Croydon, Surrey. SANderstead 3555/6

Export enquiries to: Applied Research (Instruments) Ltd. Emefco House, Reigate, Surrey, England

EE 33 060 *for further details*

"Q" and "A" of Data Logging



"Q" How to receive simultaneously frequent readings from fifteen indicating instruments and to present the resulting information in a readily assimilable manner.

"A" The equipment illustrated was designed and built for Laurence-Scott & Electromotors Ltd. and will interrogate simultaneously fifteen shaft position digitisers, transferring that information to a bank of storage relays. Each channel is then decoded in turn and the readings emerge in typewritten tabular form.

This is only one of several equipments of a similar type which has been designed and built by Gresham Lion Electronics Ltd.

What IS a NANOSCOPE?

NANOSCOPE is the registered name of an auxiliary unit (developed at the A.E.R.E., Harwell) which enables a normal, D.C. coupled oscilloscope having a bandwidth not exceeding 50 kc/s to display millimicrosecond phenomena. May we send you the Nanoscope leaflet?

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TWICKENHAM ROAD
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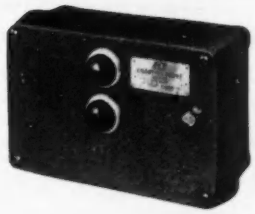
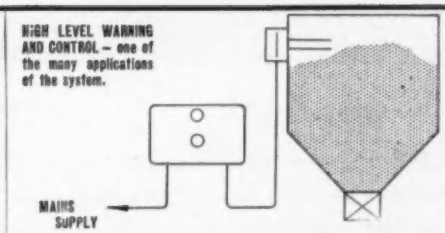
Telephone Feltham 2271

FULL?
EMPTY?

The Firth Cleveland Vibrating Probe Level Control gives you instant detection and accurate control of the level of low density granular materials. It is completely reliable, since it incorporates no moving parts and employs a printed circuit control unit which may be situated up to 300 ft. from the storage vessel, hopper etc. The system may be coupled to any type of emptying or filling equipment and will operate equally with pressurized or non-pressurized tanks of any shape or size.

Both units are of extremely robust construction and completely weather-proof. No adjustments are necessary on installation, maintenance is negligible, and the system is backed by nationwide service facilities. Full technical information is yours for the asking, or we will arrange for one of our engineers to call and talk over details with you.





FCI VIBRATING PROBE LEVEL CONTROL SYSTEM

Firth Cleveland Instruments Ltd., 7 Cleveland Row, London, S.W.1 Tel: WHitehall 3100 A MEMBER OF THE FIRTH CLEVELAND GROUP

CHC 416

the ULTIMATE in radio frequency connectors . . .

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TYPES AVAILABLE!

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✳CO-AX cables
Airflex cables
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✳ ULTRA LOW
CAPACITANCE & ATTENUATION

38 STOCK TYPES
for your standard or special applications

TYPE	μμF/ft	IMPED	O.D
C1	7.3	150	.36
C11	6.3	173	.36
C2	6.3	171	.44
C22	5.5	184	.44
C3	5.4	197	.64
C33	4.8	220	.64
C4	4.6	229	1.03
C44	4.1	252	1.03

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138A CROMWELL ROAD LONDON SW7 *Telephone:* FREmantle 4421 (P.B.X.)

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FOR THE ATTENTION OF..... ● DEPARTMENT .....

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GRAND HALL

OLYMPIA LONDON
30 May–2 June, 1961

Tuesday, Thursday, Friday, 10.00 a.m.-6.00 p.m.
Wednesday, 10.00 a.m.-9.00 p.m.

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EE 33 065 *for further details*

Hewlett-Packard

Microwave measuring equipment

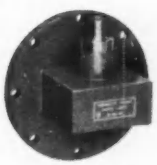
Hewlett-Packard, internationally-known electronic test instrument manufacturer, offers a complete line of microwave measuring equipment.
A few of many -hp- microwave measuring instruments are shown here.

-hp- 382 A Precision Attenuators
are direct reading, have one-control tuning and high power handling capacity. Attenuation 0 to 50 db full range, independent of frequency. For all bands, 3.95 to 40.0 KMC.
Price £ 113 to £ 205

-hp- 430 C Microwave Power Meter
gives instantaneous, automatic power readings direct in dbm and mW; usefull at all frequencies for which there are bolometer mounts.
Range 0.02 to 10 mW.
Price £ 99

-hp- 752 Multi-Hole Couplers,
precision couplers available with coupling factors of 3, 10 and 20 db, directivity better than 40 db, coupling variation not over ± 0.5 db.
Coupling accuracy ± 0.4 db, except highest ranges. For all bands 2.6 to 40.0 KMC.
Price £ 41 to £ 154

-hp- 415 B Standing Wave Indicator
for all slotted waveguide and coaxial sections. Reads in SWR or db; operates at any one frequency 315 to 2020 cps. 0.1 μV sensitivity full scale, 60 db attenuator.
Price £ 79



-hp- 487 B Thermistor Mounts,
no tuning, SWR 1.5 maximum, except highest bands; maximum power 10 mW. Each unit covers full frequency range of its waveguide; virtually no thermistor burnout due with high temperature coefficient thermistors. For all bands 3.95 through 40.0 KMC.
Price £ 31 to £ 93

-hp- 532 A Waveguide Frequency Meters,
wide band, direct reading, no interpolation or charts. Transmits almost full power at resonance; choke plunger tuning eliminates sliding contact. For H, X, P, K, R bands, 7.05 to 40.0 KMC.
Price £ 61 to £ 113

-hp- 477 B Coaxial Thermistor Mount
for frequency range 10 MC to 10 KMC. SWR less than 1.5. Thermistor element is 200 ohm negative. No tuning, not susceptible to burnout.
Price £ 31
(includes thermistor)

Many world-famous Hewlett-Packard laboratory instruments are now made in the new Hewlett-Packard GmbH plant at Böblingen, near Stuttgart. Here quality engineering and lastest manufacturing techniques bring you instruments of exceptional performance at moderate price.

Prices delivered U. K. exclusive of duty where payable. Continuous progress in design may affect the above specifications which are therefore subject to change without notice. For information, technical sales and engineering help, or a demonstration please write or call

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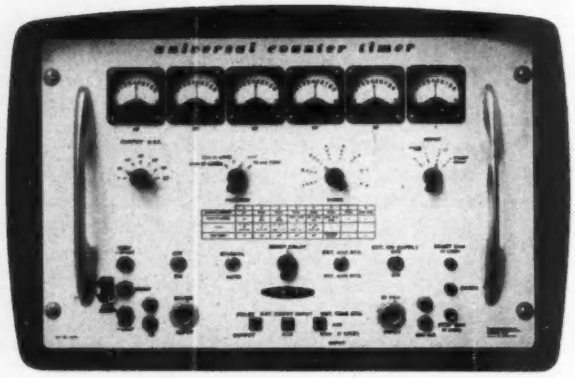
leads the way

EE 33 066 *for further details*

Transistorized UNIVERSAL COUNTER TIMER



Frequency Measurement

Random Counting

Frequency Division

Time Measurement

Frequency Standard

This fully transistorized portable equipment provides for a wide range of time and frequency measurement as well as facilities for counting, frequency division and the provision of standard frequencies. The facilities available are briefly listed below:

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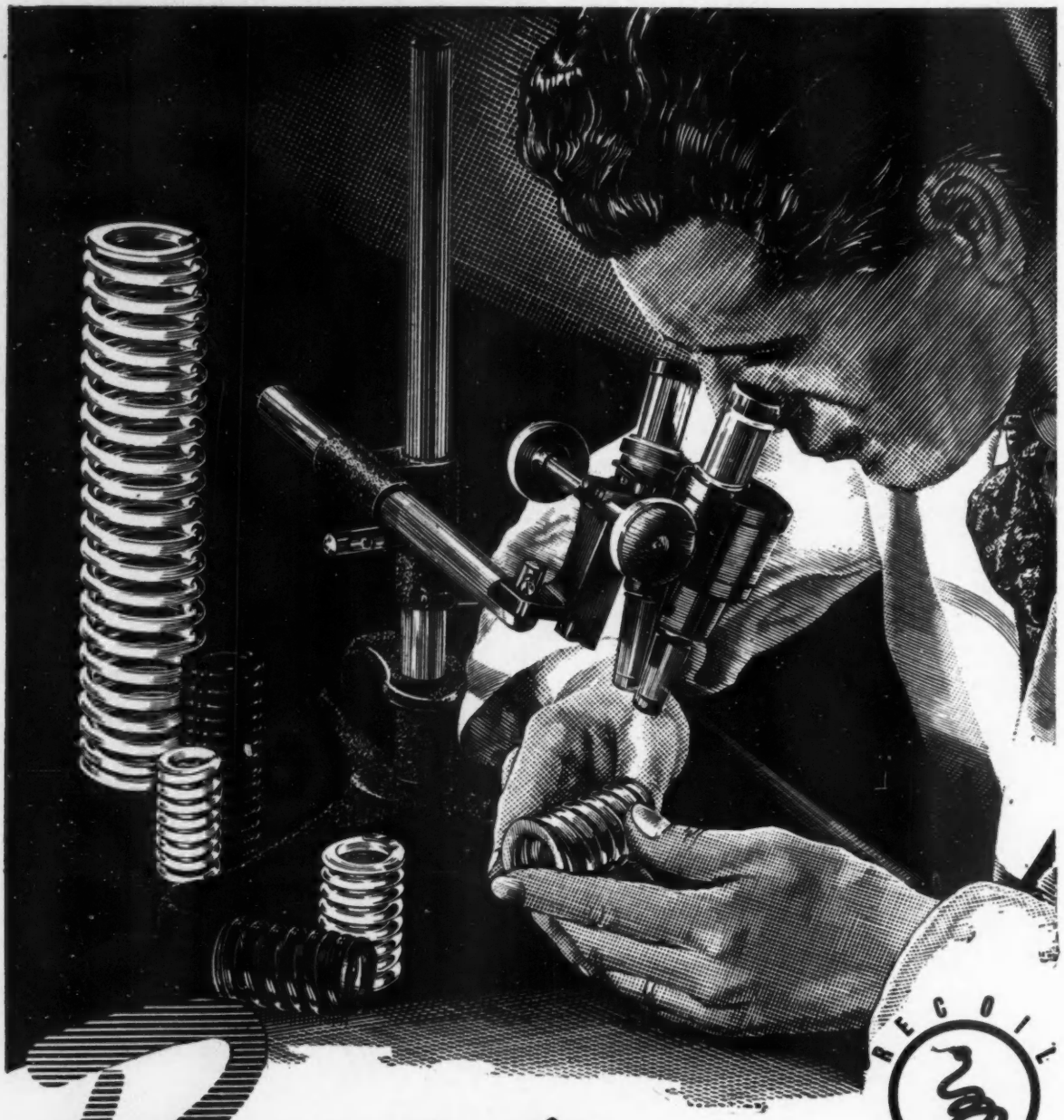

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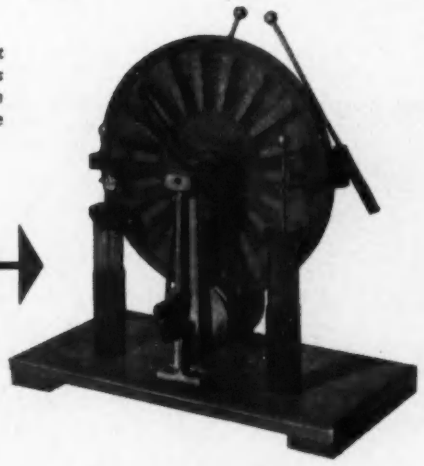
During the years 1878-1888 Mr. James Wimshurst contributed considerably to the science of physics by designing and constructing a number of High Voltage Generators of the type shown in the illustration.



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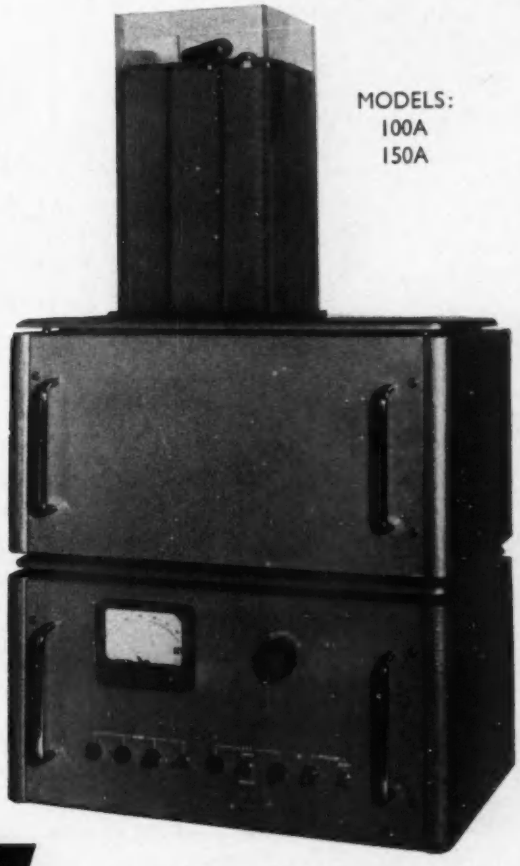

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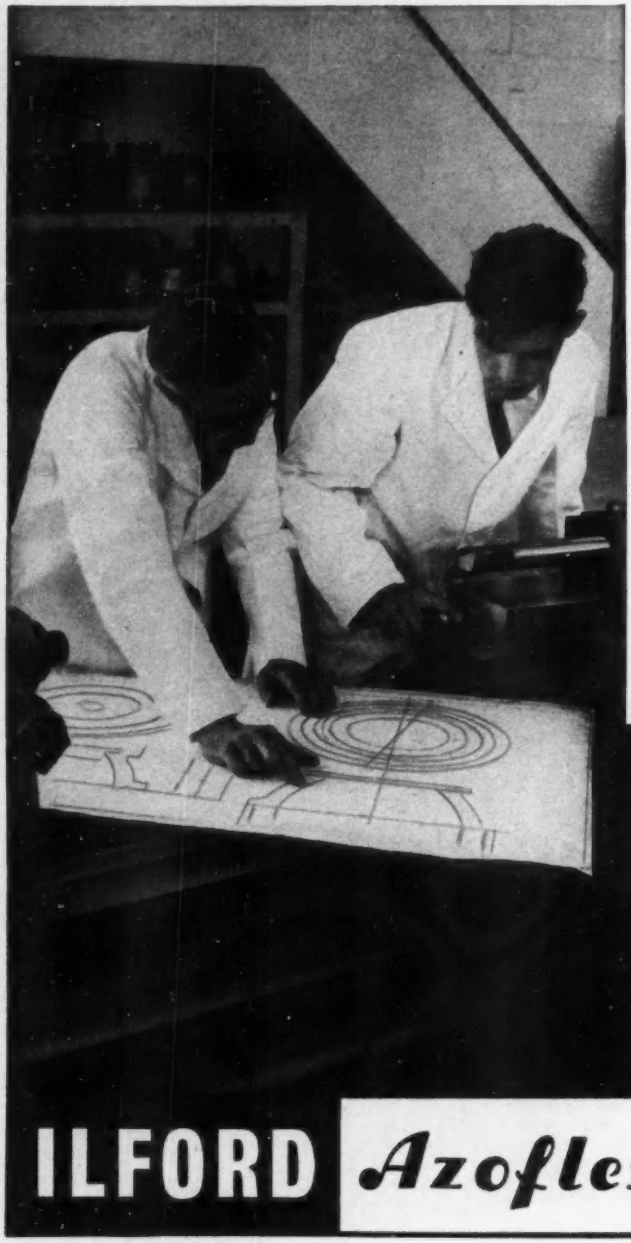
Workshop angle and D.O. viewpoint



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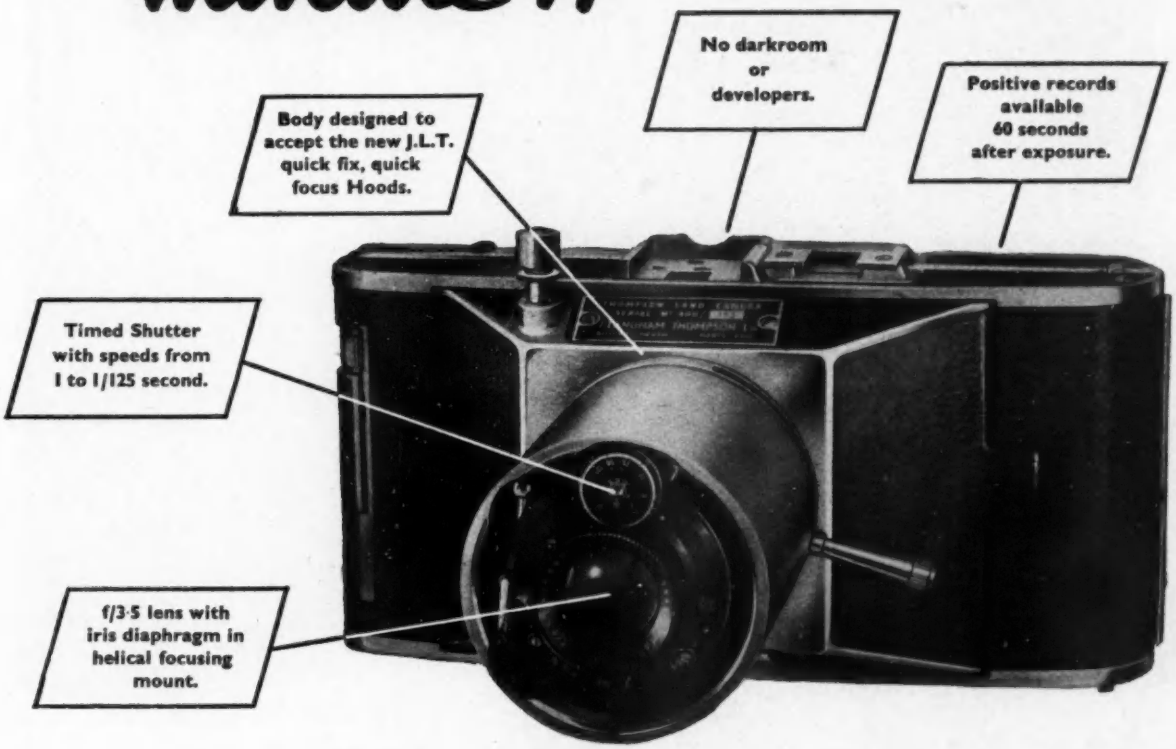
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Series 410

Improved design and performance at the same price as the Series 400, which is now discontinued.

Uses standard Polaroid roll films Types 44 and 47 producing positive prints, and Type 46L producing transparencies. These films are available ex stock.

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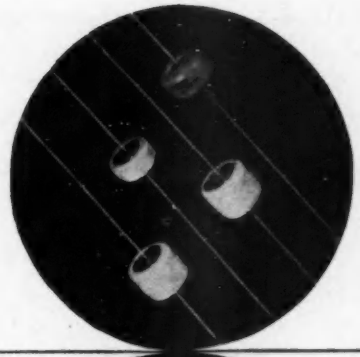

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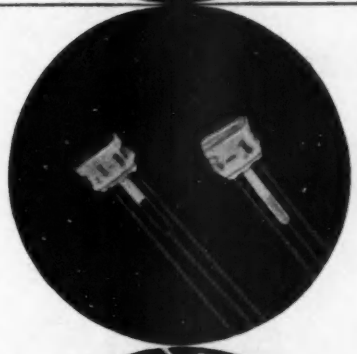

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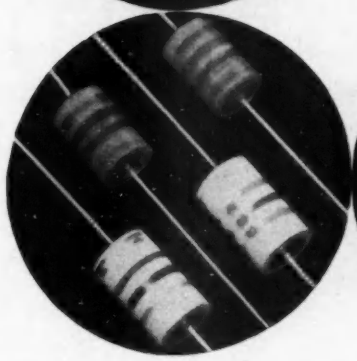
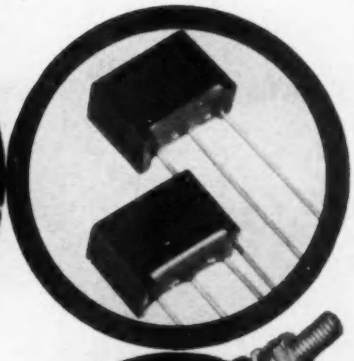
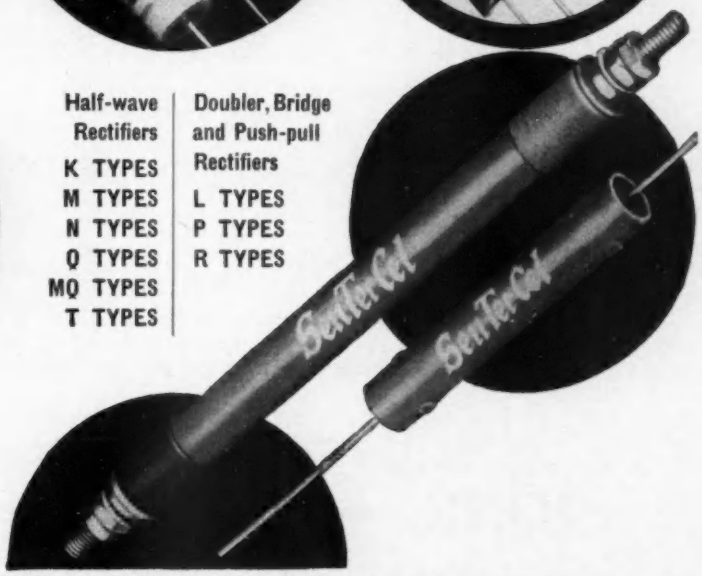




Half-wave Rectifiers	Doubler, Bridge and Push-pull Rectifiers
K TYPES	L TYPES
M TYPES	P TYPES
N TYPES	R TYPES
Q TYPES	
MQ TYPES	
T TYPES	



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for wear resistance . . . .

Electrodeposited chromium (hard chromium) with a hardness of 800—1000 V.P.N. and reasonable corrosion resistance is extensively used for wear resistance.

Electrodeposited tin nickel alloy is more corrosion resistant than hard chromium but is somewhat softer, being about 700 V.P.N. The high throwing power of the solution enables complex shapes to be coated evenly.

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A comprehensive range of germanium diodes incorporating STC's many years experience in the design and manufacture of components for Radio and TV equipment.

Application	Type
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Audio and video detector	GD12
Video detector at 36 Mc/s	GD13
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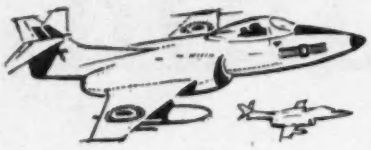
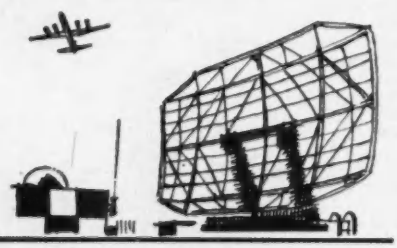
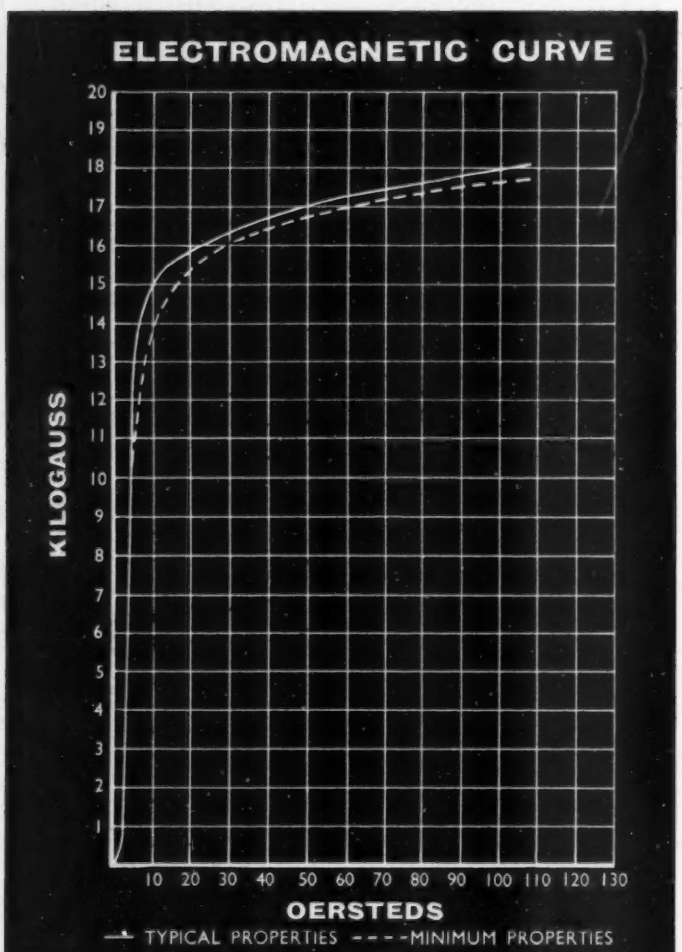
The excellent electromagnetic properties of

Purefee AND REFINED MAGNETIC IRONS

These special irons are suitable for a wide range of applications in electrical and electronic equipment. After rough machining, followed by annealing treatment, toroidal ring testing results exceeding the minima shown on the table, can be expected.







FIELD STRENGTH (H)		FLUX DENSITY (B)
Ampere Turns/cm	*Oersteds*	*Gauss(minimum)*
3·5	4·40	11,400
6·0	7·54	13,400
10·0	12·57	14,600
20·0	25·13	15,800
50·0	62·83	17,000
80·0	100·53	17,600
REMANENCE		9.000 (*minimum*)

MIDLAND AND LOWMOOR IRON & STEEL CO. LTD.

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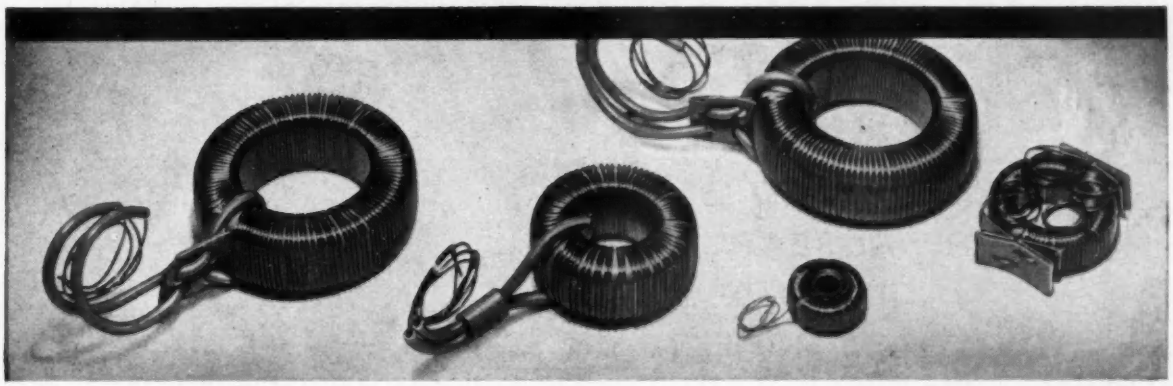
MI 16

STC

toroidal inductors for interference suppression



With the greater use of radio and navigational aids on ships and aircraft, it is increasingly important to suppress interference likely to arise from other electrical equipment which is also an inseparable part of modern transport. STC with over 40 years experience in the development of high grade magnetic materials, now introduce a selection of the many types of inductors which are manufactured for industrial, marine and aeronautical applications.

DIMENSIONS, WEIGHTS & RATINGS

SIZE CODE	DIMENSIONS AND WEIGHTS				INDUCTANCE & CURRENT RATING
	Outer Diam. cm	Inner Diam. cm	Length cm	Weight gm	(μH and Amp. AE or DC)
C1	1.3	0.7	0.52	3.5	from 250 μH ($\frac{1}{2}$ amp) to 750 μH (0.1 amp)
C2	2.3	1.2	0.8	14.5	„ 100 „ (1$\frac{1}{2}$ „) to 1000 „ ($\frac{1}{2}$ amp)
C3	2.95	1.4	1.3	50	„ 100 „ (2$\frac{1}{2}$ „) to 1000 „ ($\frac{1}{2}$ amp)
C4	4.1	2.4	1.3	85	„ 100 „ (4 „) to 2000 „ (1$\frac{1}{2}$ amp)
C5	4.8	2.7	1.4	130	„ 100 „ (5 „) to 2000 „ (2 amp)

ELECTRICAL CHARACTERISTICS OF SELECTED TYPES

CODE	Inductance at Cont. rated current (μH)	Current Rating		Volt Drop at Cont. Rated Current (V)	Self Resonating Frequency (Mc/s)	D.C. Resis. (Ω)
		Cont. (A)	Peak (A)			
C1AB 300	300 ± 10%	0.5	0.7	0.25	5.0	0.5
C2BB 500	500 „ „	1.0	1.2	0.30	3.2	0.3
C3BC1000	1000 „ „	1.5	2.2	0.45	1.2	0.3
C4CC1000	1000 „ „	2.0	3.5	0.44	0.9	0.22
C5DD1000	1000 „ „	3.0	4.4	0.54	0.8	0.18

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STC COMPONENTS GROUP

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STC

HIGH SLOPE FRAME GRID VALVES

FOR WIDE BAND,
LOW NOISE
LOW DISTORTION AMPLIFIERS

Type	g_m (mA/V)	Figure of Merit	Typical I_a (mA)	Max P_a (W)	Classification
3A/167M	47	370	40	6·5	Triode
5A/170K	16·5	185	13	3·3	Beam Tetrode
5A/180M	32	180	26	6	Beam Tetrode

COMPONENTS GROUP

61/4MS

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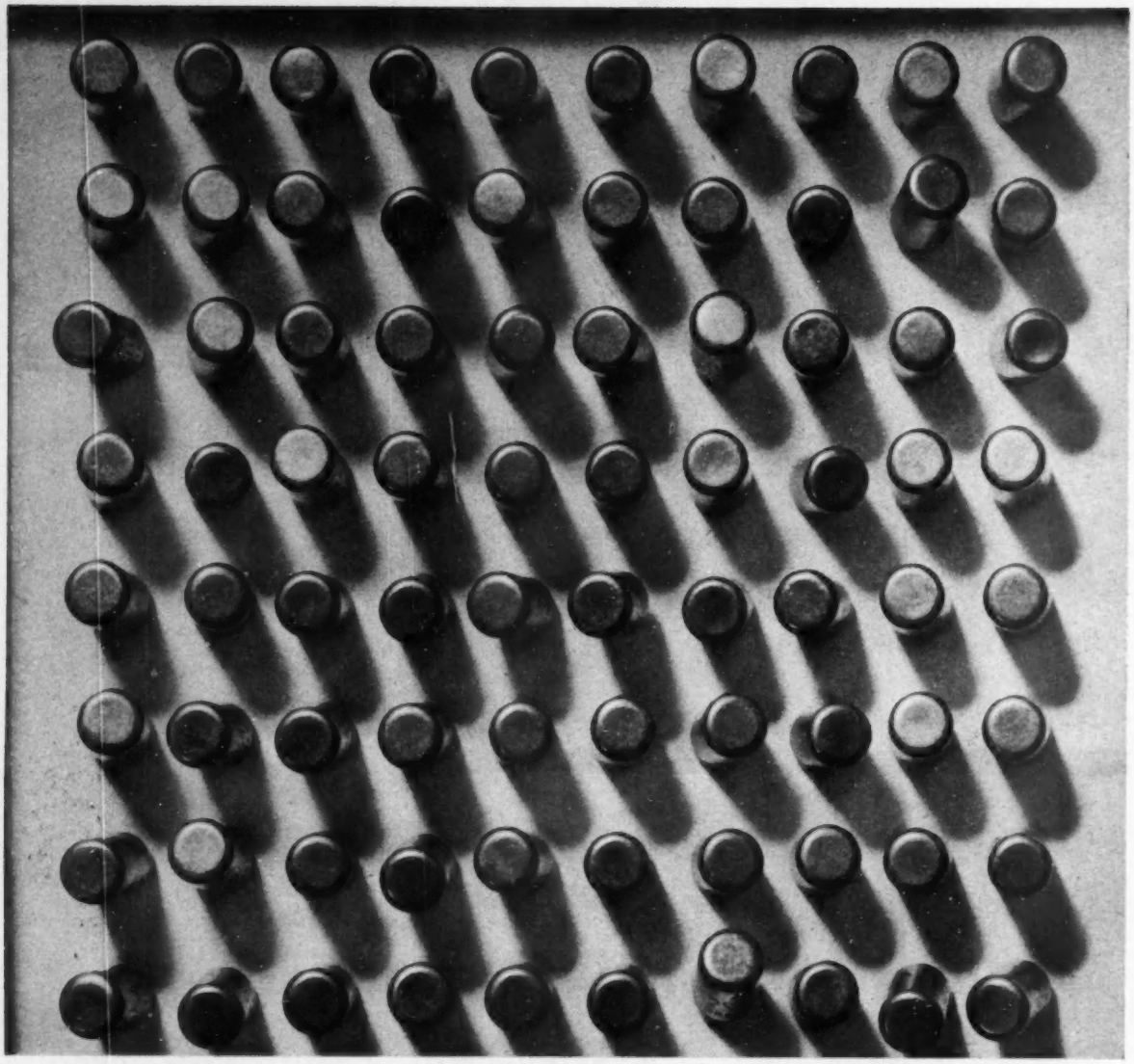
VALVE DIVISION: FOOTSCRAY · SIDCUP · KENT



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2SA50	For Switching Purpose
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2SA53	For Intermediate Frequency Amplifier Service
2SB26	For Audio Frequency Power Amplification
2SB47	Low Noise Factor with Audio Frequency Amplifier
2SB54	For Low Frequency Amplifier Service
2SB56	For Audio Frequency Power Amplifier Service
2SB189	For Medium Power Output Service

Germanium PNP Alloy Type DRIFT TRANSISTORS

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2SA59	For High Frequency Amplifier Service
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MEGOHMMETER

Type IM5

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Measurement on capacitors, resistors, and insulating materials.

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Large meter, 6" scale.

Provisions for measurement on three-terminal resistors: built-in leakage current guard.

Measuring Range:

1 Megohm to 100 Million Megohms.

Scale calibrated from 1 Megohm to 100 Megohms, range multipliers: x 1, x 10,—x 10^6.

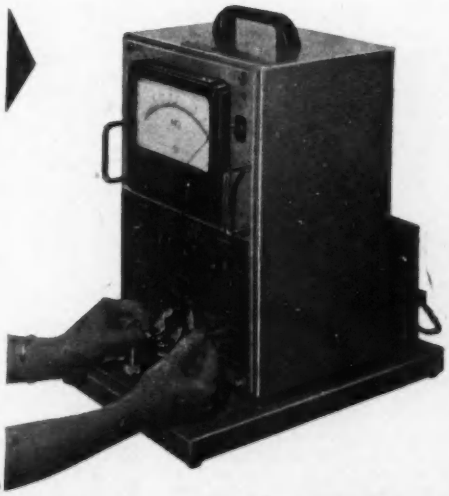
Test Voltages:

50, 100, 200, 500, and 1000 volts d.c.

The complete measuring range can be used at all test voltages.

Accuracy:

2% to 5% depending on the range.



FOR PRODUCTION

1000 to 2000 components tested per hour when Megohmmeter is used with the new electrically operated Component Jig, type KPH1M1.

The clamping mechanism is actuated by the function selector of the Megohmmeter. Adjustable spacing between terminal posts.

Automatic charging of capacitors permits fast operation, even on large units.

Provisions for fast go-no-go measurements.

Capacitors automatically discharged before release.

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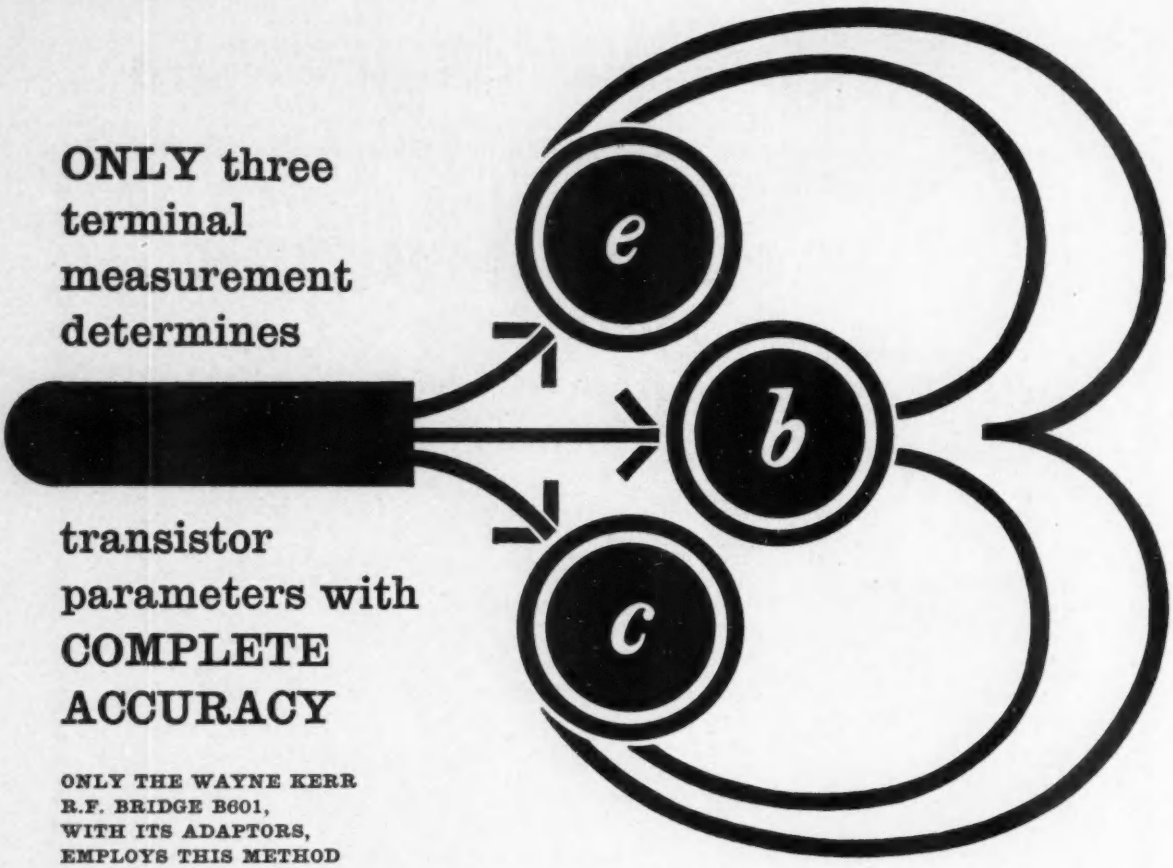
EE 33 062 *for further details*

ONLY three terminal measurement determines transistor parameters with COMPLETE ACCURACY



ONLY THE WAYNE KERR R.F. BRIDGE B601, WITH ITS ADAPTORS, EMPLOYS THIS METHOD

A multi-ratio instrument for the measurement of resistance, capacitance and inductance over a wide range of values, the R.F. Bridge B601 uses the ratio-arm technique and provides the three terminal measuring facility that is essential to obtaining true parameters. In addition, the bridge will measure complex impedances, balanced or unbalanced, or balanced with the centre point earthed and is extremely suitable for measuring the impedances of the very low Q elements.

It is fitted with coaxial leads for connexion to a separate source and detector, and has the advantage of extreme stability due to the fact that the impedance looking back into the terminals and the impedance to ground at balance are both exceedingly low.

SPECIAL ADAPTORS. To enable parameter plotting for the widest range of semiconductors, a special series of adaptors has been developed. The form of these Q601 Series adaptors is such that they introduce minimum error (usually less than 1%) over the full frequency range of the bridge.

SEE THIS SYSTEM DEMONSTRATED ON OUR STAND No. 38 AT THE INTERNATIONAL TRANSISTOR EXHIBITION

WAYNE KERR

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WKLI

EE 33 083 *for further details*

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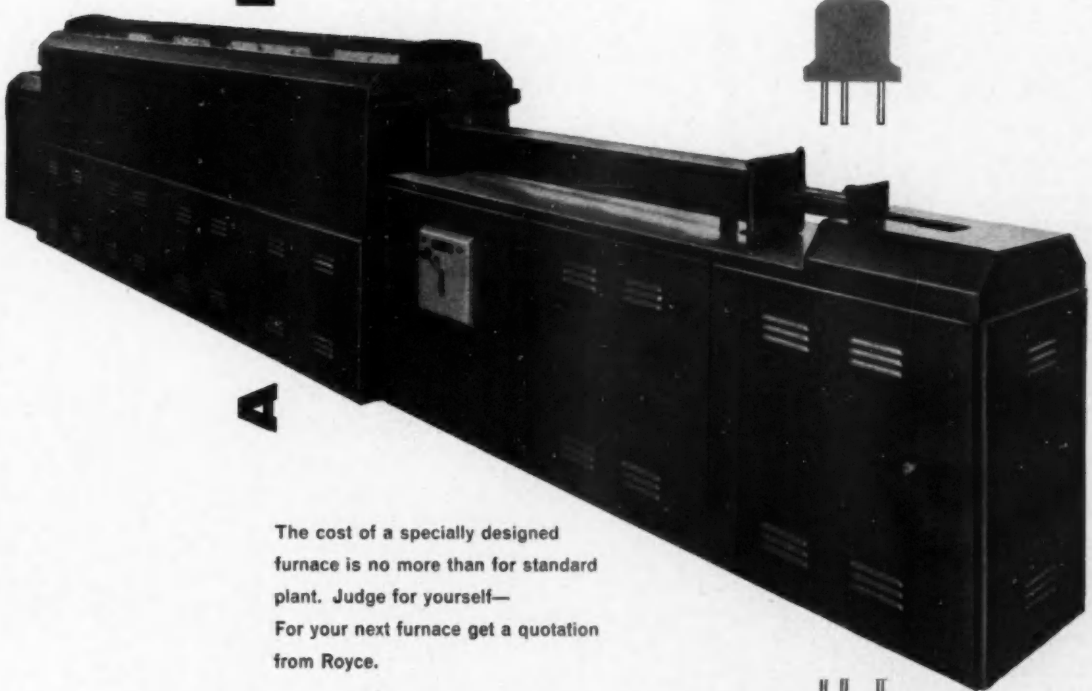
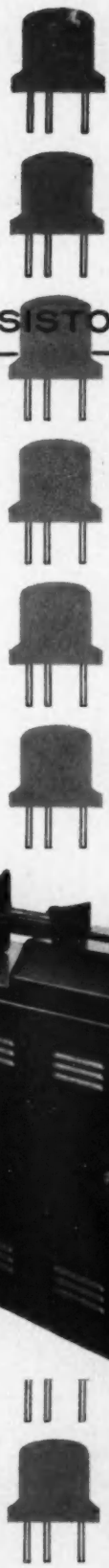


The cost of a specially designed furnace is no more than for standard plant. Judge for yourself—
For your next furnace get a quotation from Royce.



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- Direct frequency measured 0-10 Mc/s.
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- Self-contained Frequency Standard 1 part in 10^7.
- Clock pulse source.
- Operates remote read-out or digital printer.
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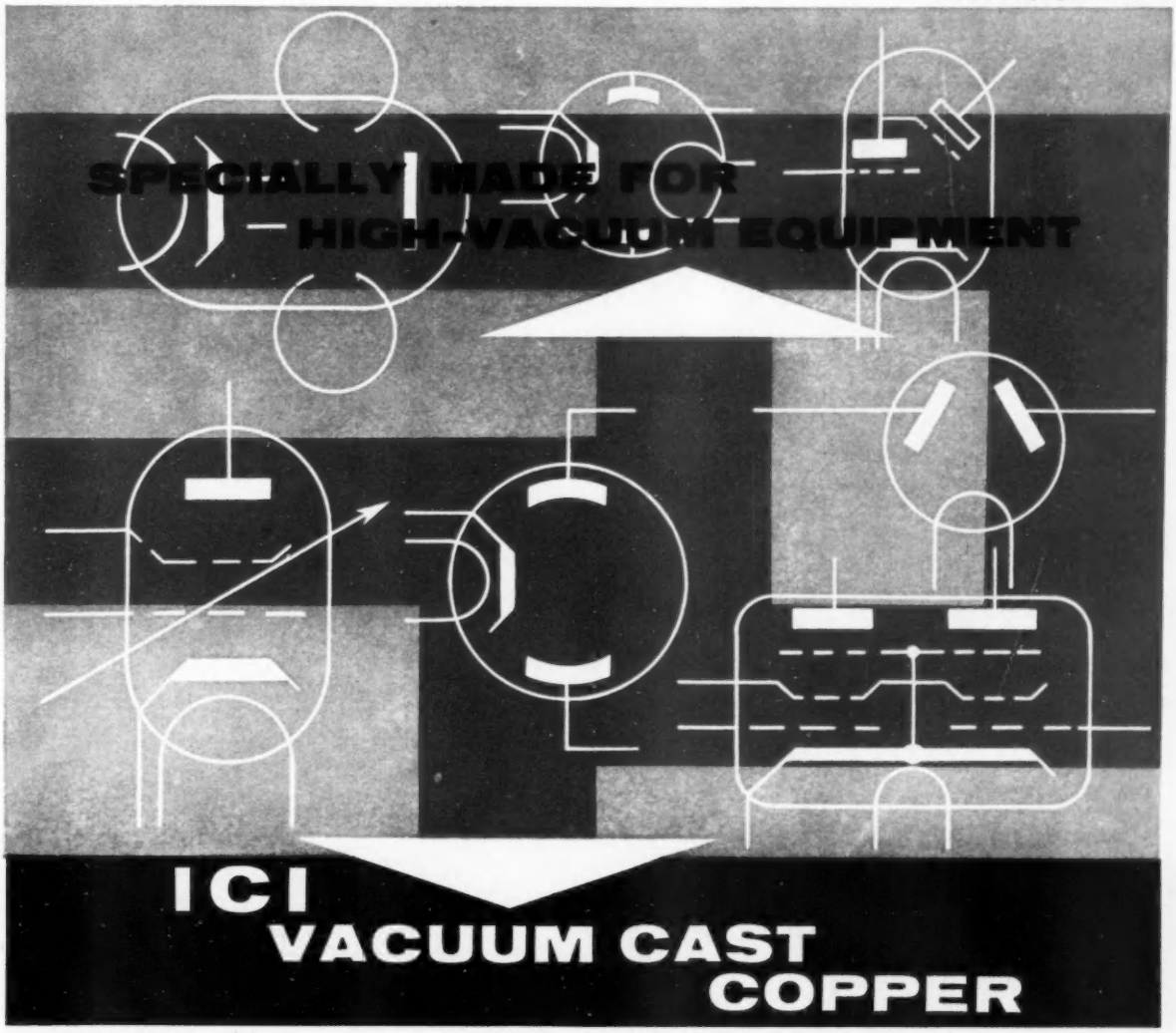

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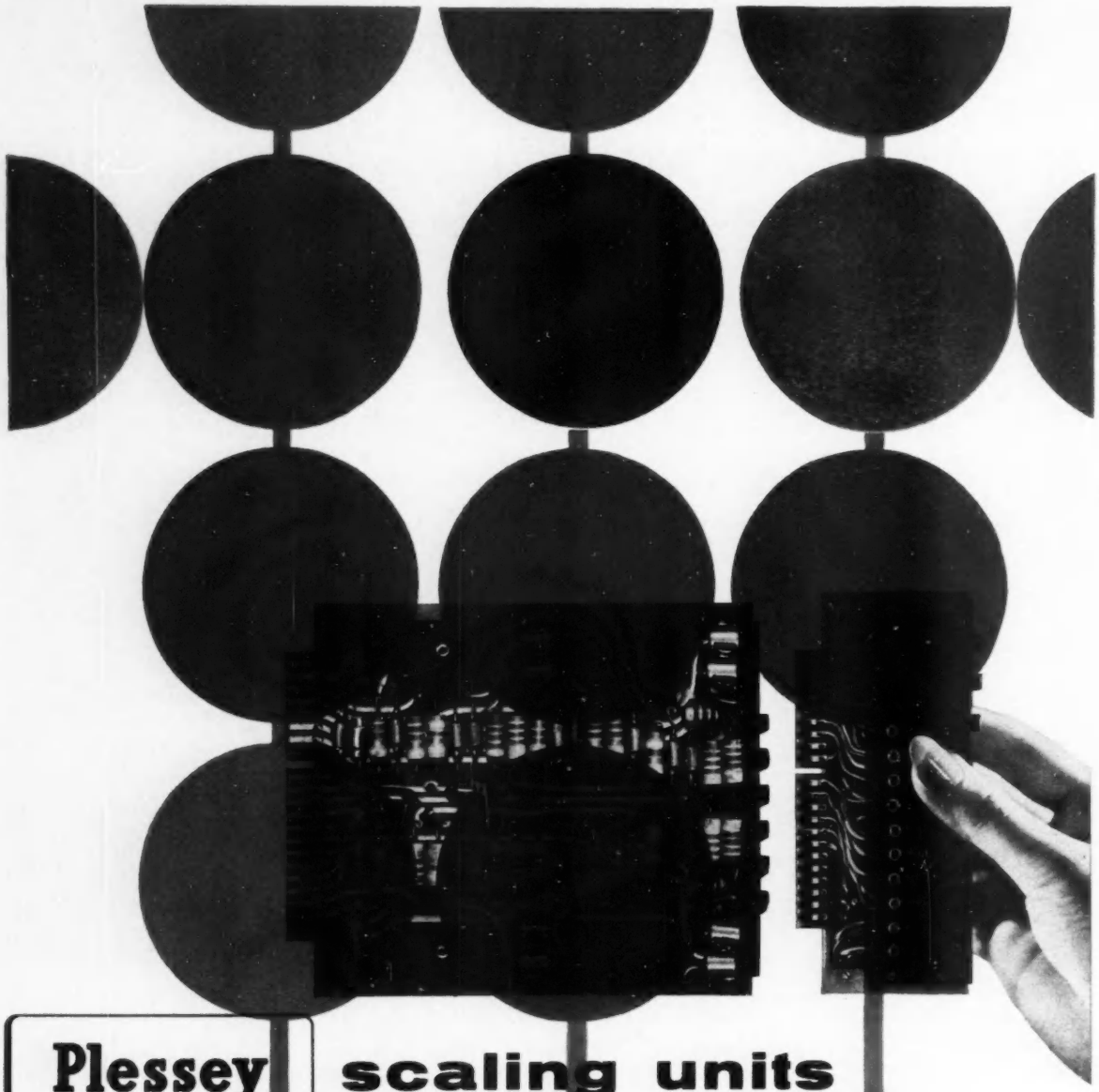

Plessey scaling units

for counting and computing

Plessey Nucleonics are now manufacturing two types of Scaling Unit—a **Decade Scaler** and a **Binary Scaler.** Both are of small overall dimensions and are engineered on plug-in printed circuit boards for general-purpose applications.

The **Decade Scaler** (AERE Type 1603A) has a resolution time of less than 1.5 microseconds and a maximum scaling frequency in excess of 250 kc/s. It provides a 2 microsecond pulse at up to 100 mA and can be stepped by either positive- or negative-going pulses of 0.5 to 1 microsecond width.

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There are no lenses, no lamps, no moving parts—this is a solid state device with practically no running costs, plus of course extreme reliability. Further, cost per character related to height and variety is considerably cheaper than any other available readout device.

The elements constituting the characters are deposited within ¼" of the front surface, each occupying the same area, which results in an extremely wide-angle viewing, in-line, co-planar display. In the P40 the characters are approximately 4" high giving a readout at distances of up to 200'.

The thickness of the device is less than ½" which means a vital saving of valuable installation space.

For more personalized digital displays Type P21 (1" characters) is also in production.

P40 BRIEF ELECTRICAL AND MECHANICAL DATA

Maximum operating voltage	**250V**
Normal operating voltage	**240V**
Operating frequency range	**50 to 1000 c.p.s.**
Current consumption per element—	
(Nominal at 240V/50 c.p.s.)	**60μAs**
(Nominal at 240V/400 c.p.s.)	**500μAs**
Surface brightness—	
(Nominal at 240V/50 c.p.s.)	**1ft.L**
(Nominal at 240V/400 c.p.s.)	**8 ft.L**

Maximum length	**5.50 in.**	**13.97 cms.**
Maximum breadth	**4.00 in.**	**10.16 cms.**
Maximum thickness	**0.375 in.**	**0.953 cms.**

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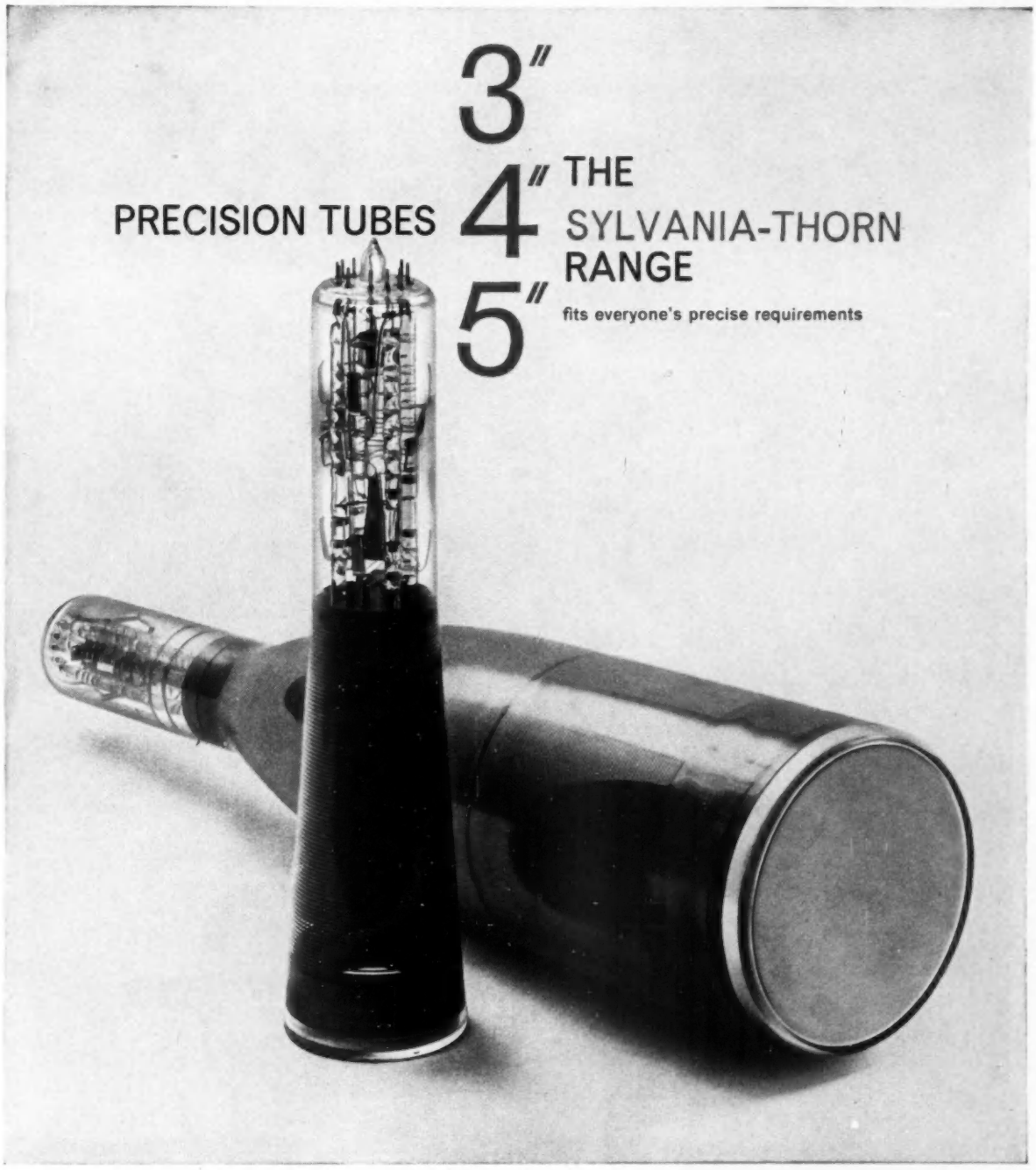

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MAIN TYPES (Typical Operating Conditions)

Face Diameter	5″	5″	5″	5″	5″	4″	4″	3″
Type No.	2S5C	SE5A	SE5B	SE5D	SE5E	SE4A	SE4B	SE3A
Final anode voltage & PDA Ratio	12 4.8	10kv 6.67	10kv 6.67	10kv* 12	10kv 12	8kv 4	4kv 4	4kv 4
Screen Area cms x cms	8 x 10	6 x 10	4 x 10	4 x 10	6 x 10	5 x 8	5 x 8	5 x 6
Y sens. v/cm	15	10	7	3.5	5.5	15	7.5	7.5
X sens. v/cm	33	30	30	14	14	48	25	27

* at 7.5kv Sy 2.50 v/cm Sx. 10 v/cm Sensibility better than 0.14 v/line width

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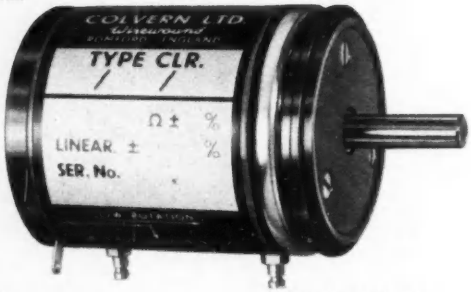
TYPE CLR.26/00 Multi-Turn Helical Potentiometer

Specification



RATING	**0.4 watts per turn**
RESISTANCE RANGE	**10Ω—10KΩ per turn**
RESISTANCE TOLERANCE:	
Standard	±5%
Best Practical	±1%
ABSOLUTE LAW ACCURACY	**Std.** ± 0.25% **Spec.** ± 0.1 % **(10 turn)**
MAX. WORKING VOLTS SPINDLE/TRACK	**1000 V.D.C.**
EFFECTIVE RESISTANCE ANGLE TOL.	±1°
MAX. STARTING TORQUE	**1½ oz/in.**
MIN. ANGLE BETWEEN TAPS	**90°**
MAX. GANGED SECTIONS	**2**

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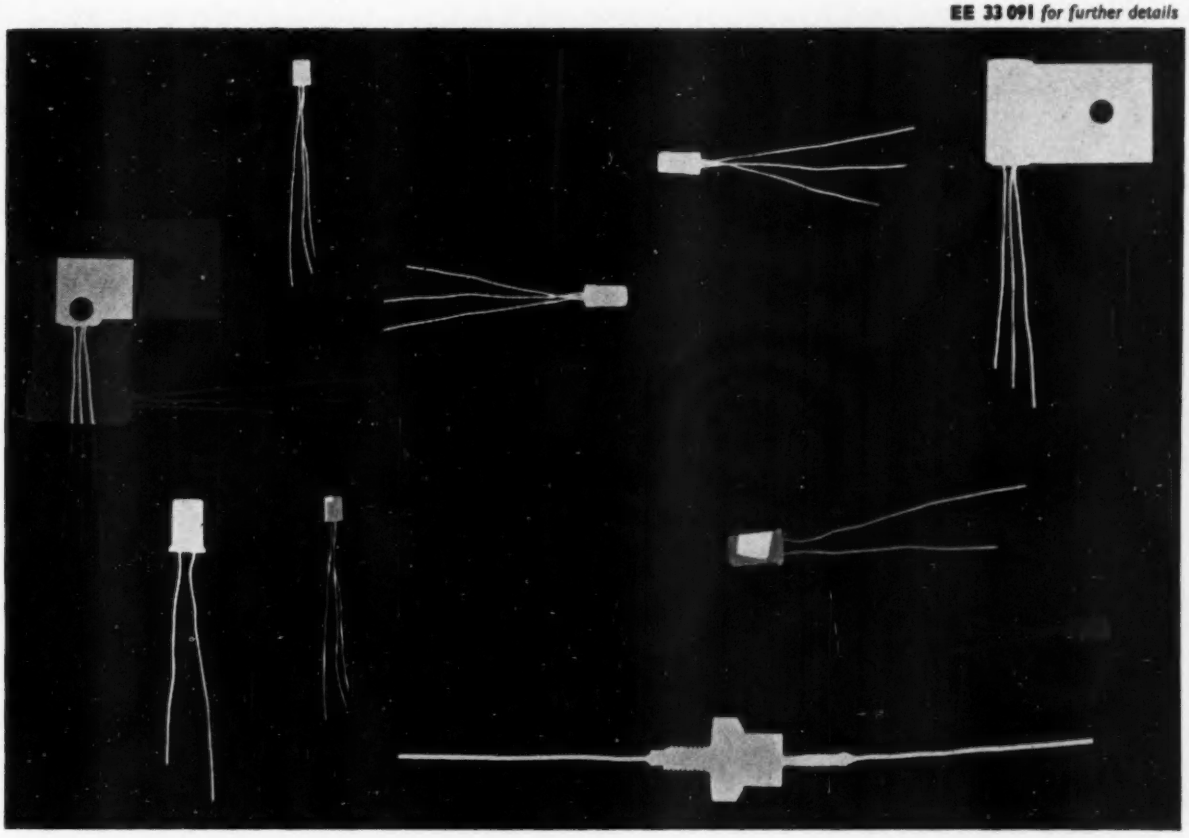

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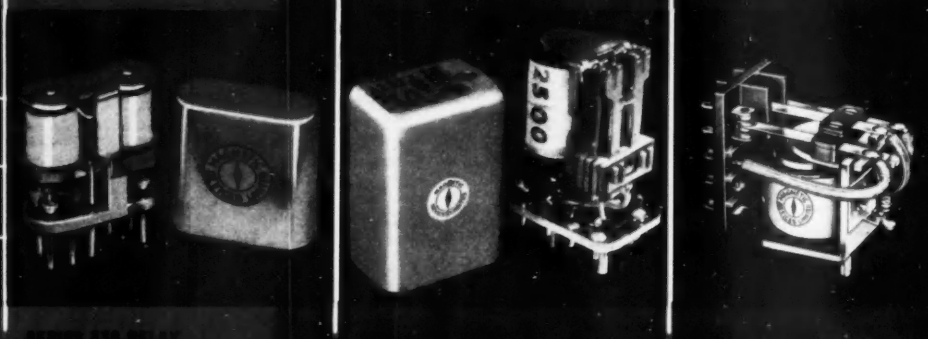
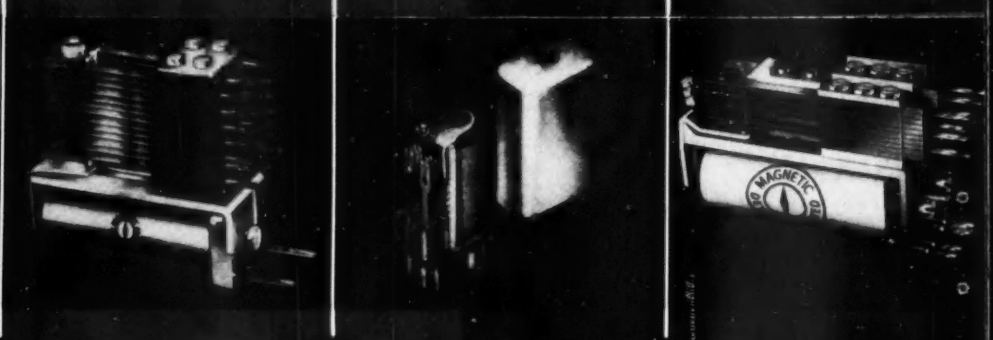
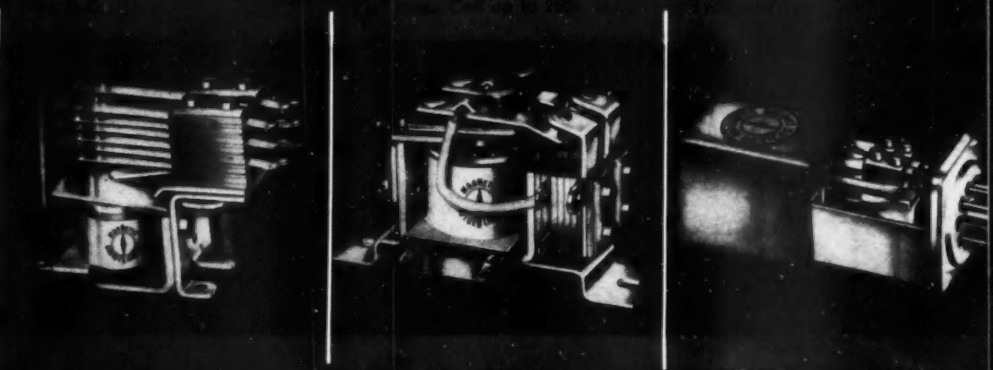
Relay	Max. D.C. Coil resistance	Max Op Voltage	Coil Loading	Max Contact Rating
336	7,250	85	1 watt	2 amps.
315	2,500	48	1.25 watts.	10 amps.
320 325	9,200	440 250	5 VA 2.5 watts	10 amps. at 30v. D.C.



Relay	Max. D.C. Coil resistance	Max. Op. Voltage	Coil Loading	Max. Contact Rating
285	12,500	250	3.6 watts (max.)	6 amps.
2400	14,000	240	0.16–4 watts	5 amps.
305	40,000	250	80 milliwatts to 6 watts	8 amps.



Relay	Max. D.C. Coil resistance	Max. Op. Voltage	Coil Loading	Max. Contact Rating
100 105	6,000 10,800	440 250	3–6 VA 1.5–3 watts	10 amps.
151 156	7,500 9,800	440 250	5–6.6 VA 2.6–3.3 watts	15 amps.
596HS	1,400	24	Independent of controlling supply	5 amps.



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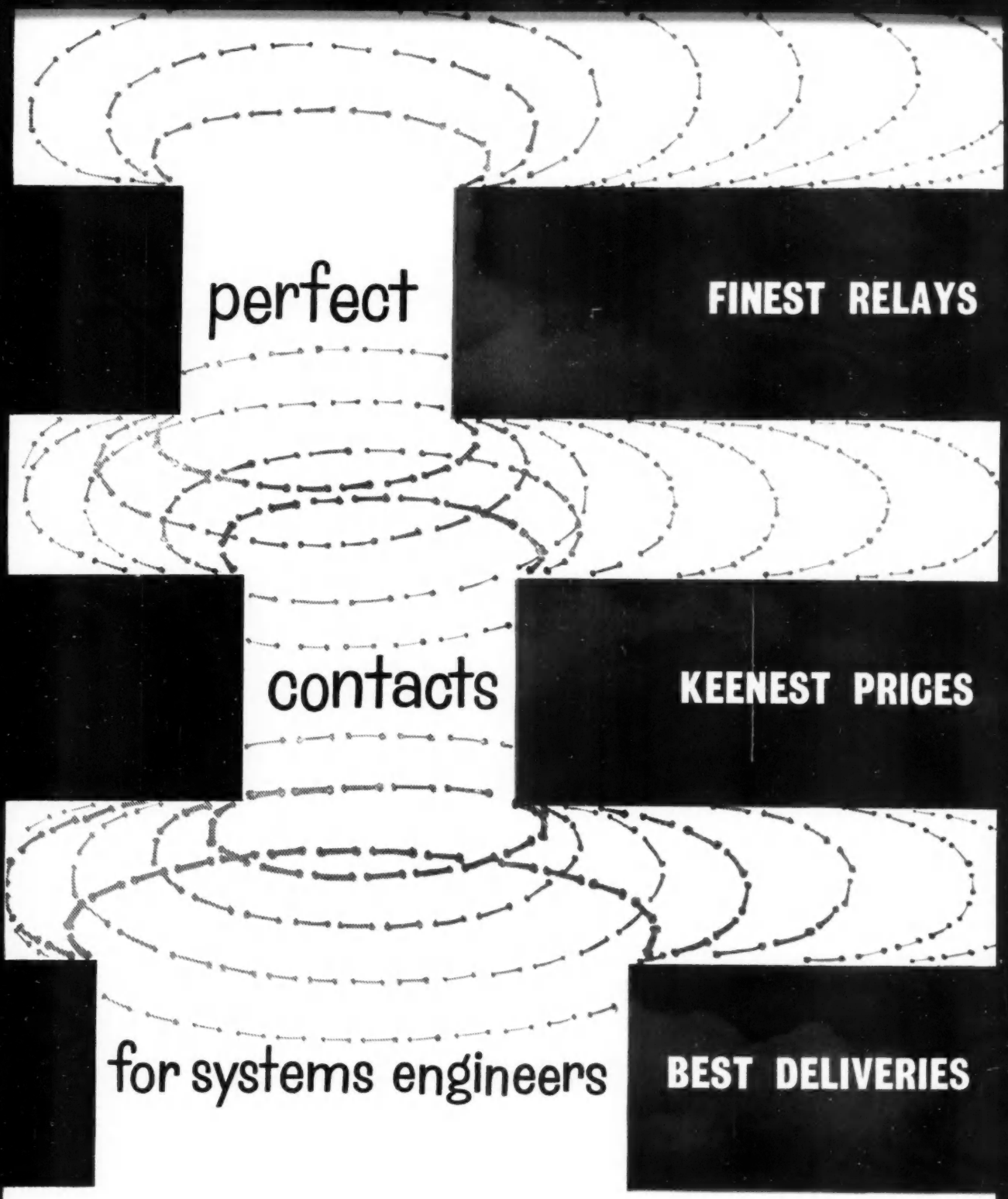

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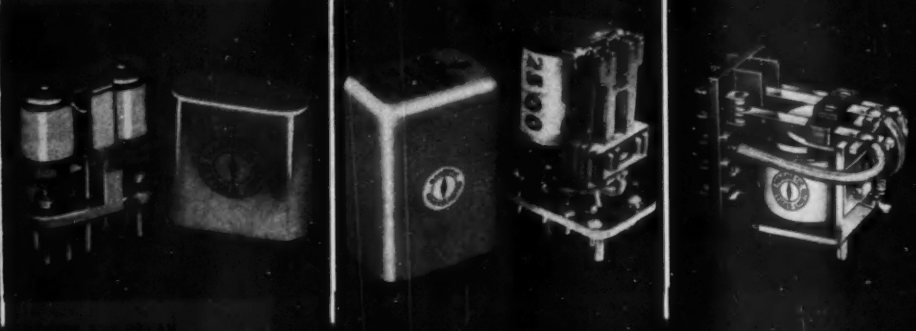
Relay	Max D.C Coil resistance	Max Op Voltage	Coil Loading	Max Contact Rating
336	7,250	85	1 watt	2 amps
315	2,500	48	1·25 watts	10 amps
320 325	9,200	440 250	5 VA 2·5 watts	10 amps at 30v. D.C



Relay	Max D.C Coil resistance	Max Op Voltage	Coil Loading	Max Contact Rating
285	12,500	250	3·6 watts (max.)	6 amps
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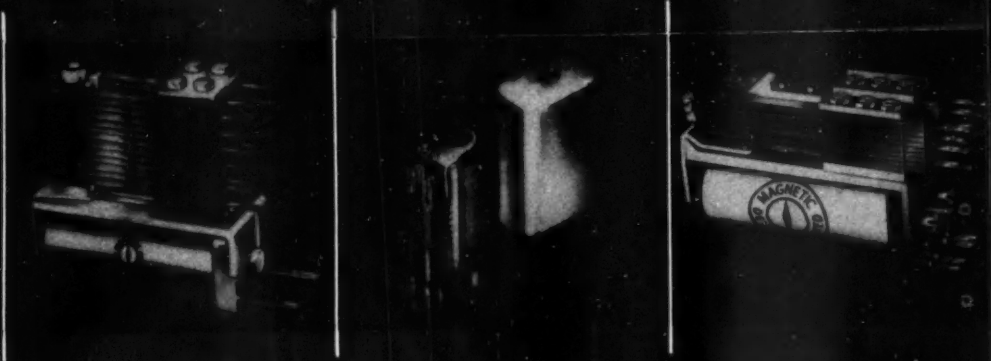
305	40,000	250	80 milliwatts to 6 watts	8 amps



Relay	Max D.C Coil resistance	Max Op Voltage	Coil Loading	Max Contact Rating
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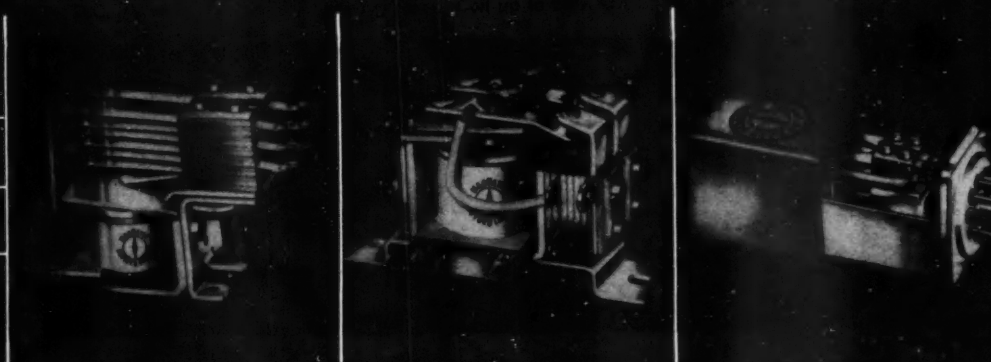
151 156	7,500 9,800	440 250	3–6·6 VA 1·6–3·3 watts	15 amps
596H5	1,400	24	Independent of controlling supply	5 amps



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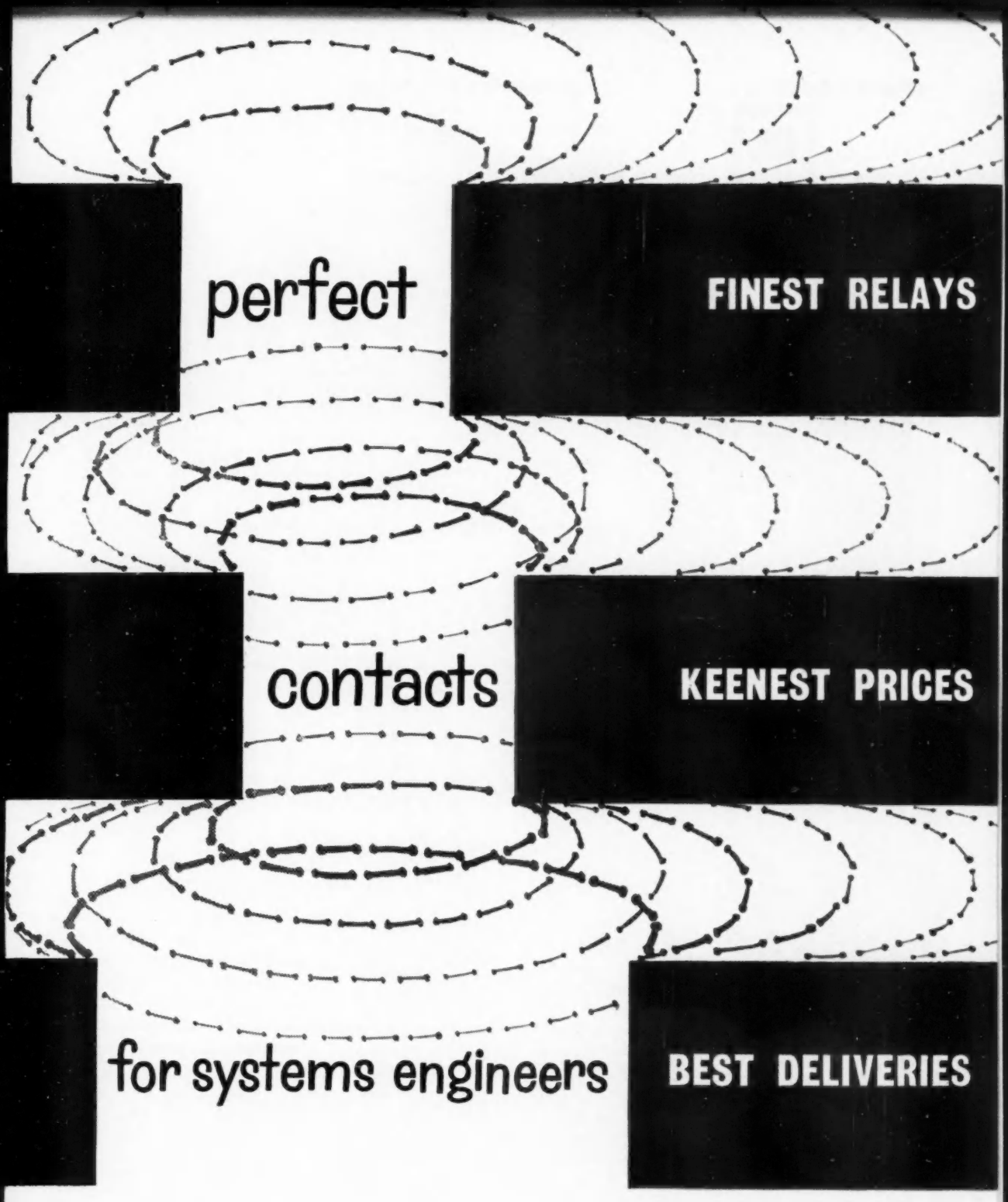

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Collector Current	50	50	50	50 mA
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Common Emitter A.C. Current gain h_{fe}	30*	60*	30*	45*	V_{CE} = 6V I_C = 1mA
Collector Saturation Voltage. Max. V_{CE} sat.	0·5V	0·5V	1·0V	1·0V	I_C = 10mA I_B = 2mA
Gain Bandwidth Product. Min. f_T	50mc/s	50mc/s	50mc/s	50mc/s	V_{CE} = 6V I_C = 10mA

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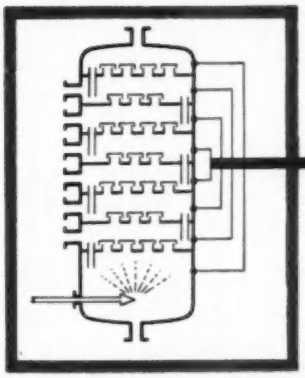
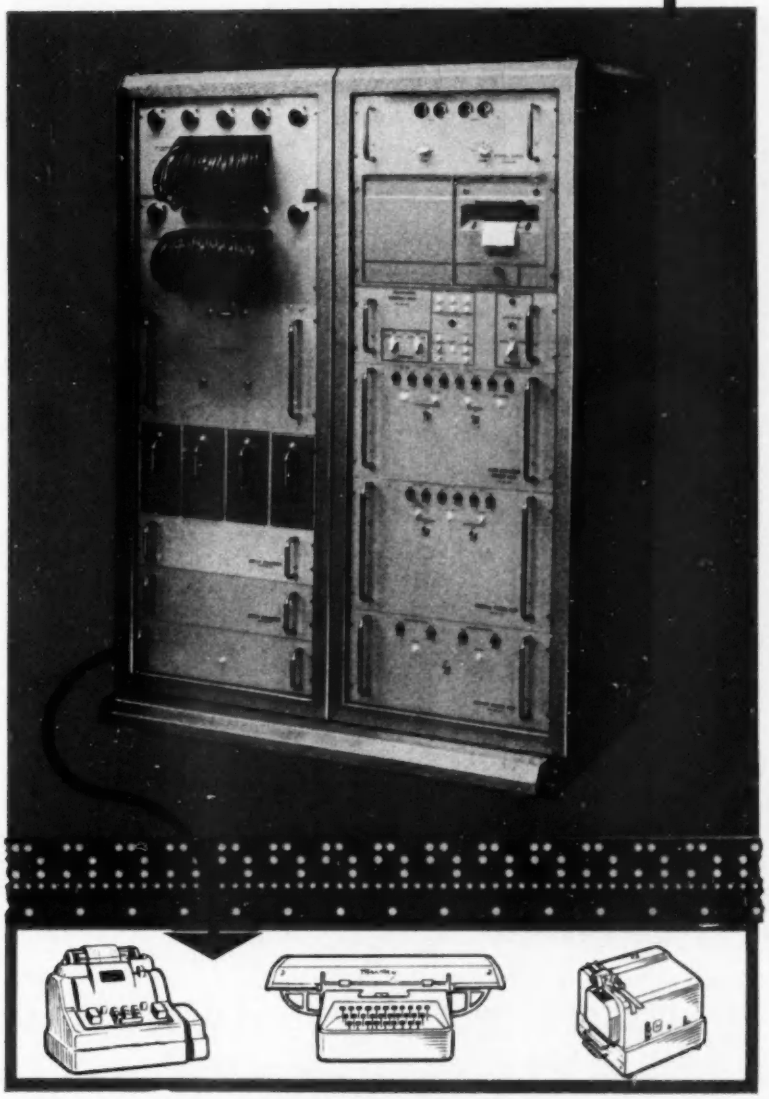


BE Data Logging Equipment



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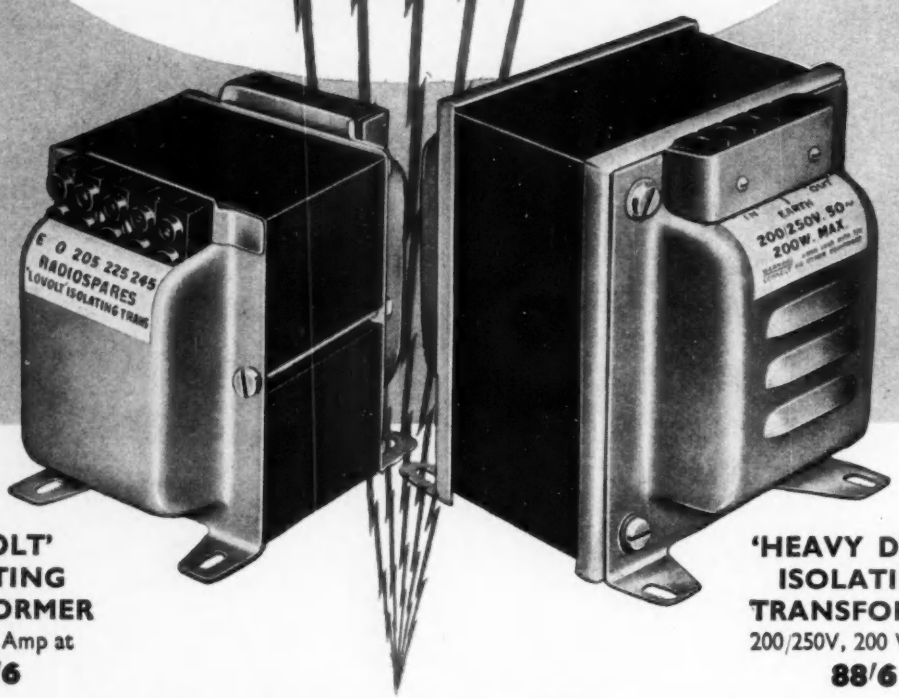

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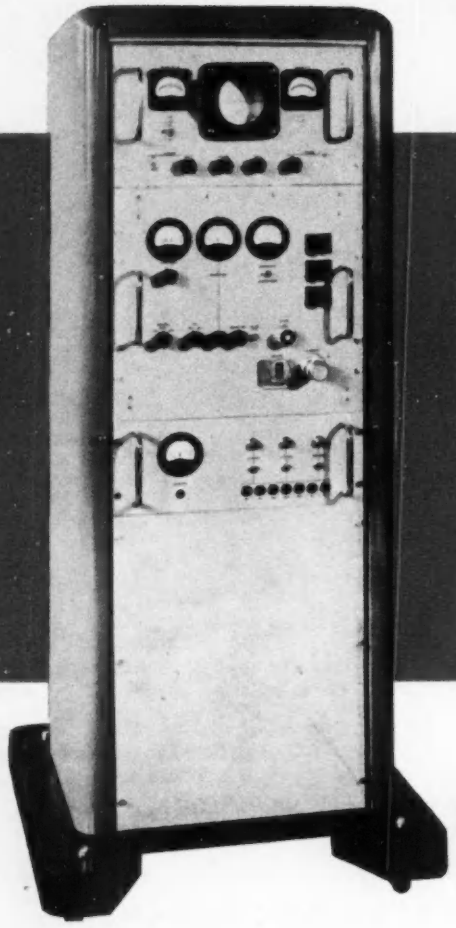

A new Panoramic Spectrum Analyser for the examination of phase noise and line sideband spectra in frequency bands up to ±150 Kc/s relative to carrier.

The resolution is 1 Kc/s and, with a nominal input power of 1 micro-watt, sideband noise powers in a 1 Kc/s bandwidth 60 dbs below carrier level may be measured.

The panoramic display can be adjusted to examine any 25 Kc/s portion of the spectrum as an alternative to the examination of a 300 Kc/s spectrum range. Frequency deviation is easily measured by means of a calibrated moving coil meter and sideband amplitudes may be accurately determined by comparison with the carrier level by means of a built-in decade attenuator.

The equipment illustrated has an R.F. tuning range from 8.2 to 10.0 Kmc/s. Enquiries for other frequency bands are invited.

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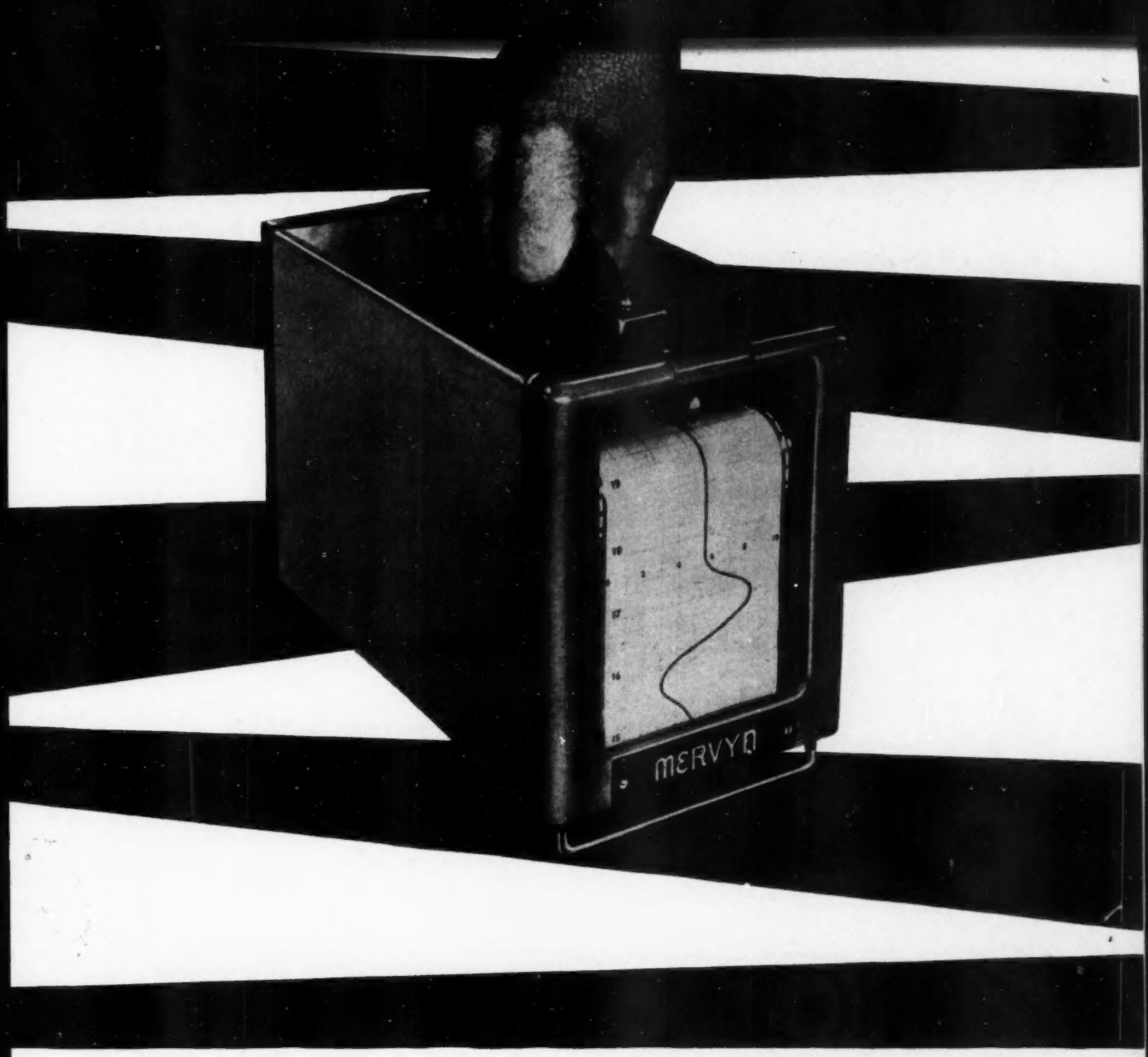

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Actual size

Waveform monitoring at extremely low cost with the 1CP31

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The tube itself is inexpensive and the associated circuitry required is very simple. The operating voltage is so low that in most equipment suitable connection to existing H.T. lines is all that is required. Beam focusing is fully automatic and auto-bias is quite adequate.

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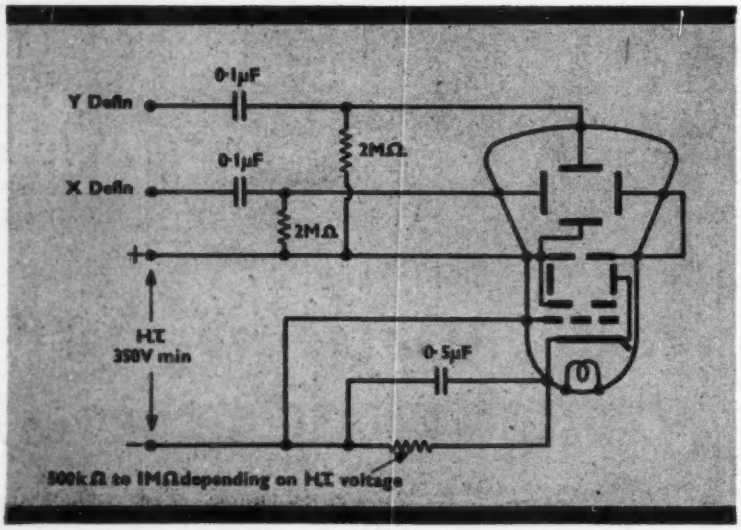
Vh	=6.3V
vh−k(pk)	max. =±250V
Va_1+a_3	min. =350V
Sx	$=\frac{95}{Va_3}$ mm/V
Sy	$=\frac{110}{Va_3}$ mm/V

(The green medium persistence phosphor used by E.T.L. has now been designated P31. It is exactly the same as the E.T.L. phosphor previously called P1.)



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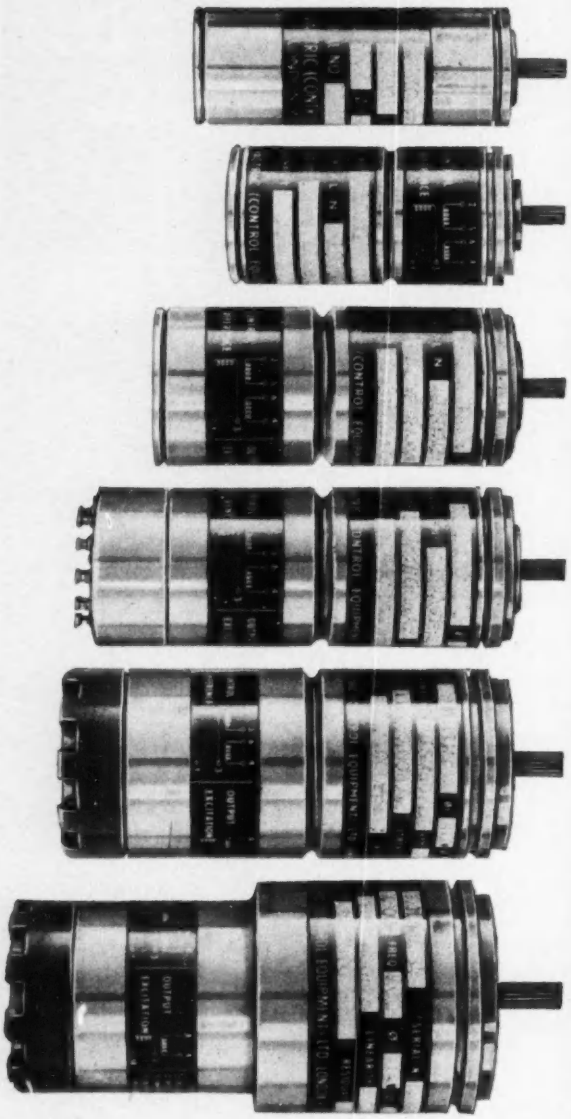

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. . . provide the required stability for servo systems. They are miniature precision built components of low inertia, low residual and good linearity. They conform to Ministry of Aviation Specifications which require normal operation for 1000 hours at altitudes up to 60,000 feet.

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Weight 82 grams.

SIZE 10
Std. 2-phase 26v. 400 c/s motor.
Tachogenerator output 0.4v/1000 r.p.m.
Residual 20 m.V. max., Linearity ±0.5%
Weight 108 grams.

SIZE 11
Std. 2-phase 115v. 400 c/s motor.
Tachogenerator output 0.5v/1000 r.p.m.
Residual 20 m.V. max., Linearity ±0.5%
Weight 200 grams.

SIZE 11 (with temperature compensation)
Std. 2-phase 115v. 400 c/s motor.
Tachogenerator output 0.45v/1000 r.p.m.
±3.5% over −40°C to +100°C or
±1.5% over −20°C to + 80°C. } Body Temp.
Residual 20 m.V. max., Linearity ±0.5%
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SIZE 15
Std. 2-phase 115v. 400 c/s motor
Tachogenerator output 3.0v/1000 r.p.m.
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Std. 2-phase 115v. 400 c/s 18 A.C. motor.
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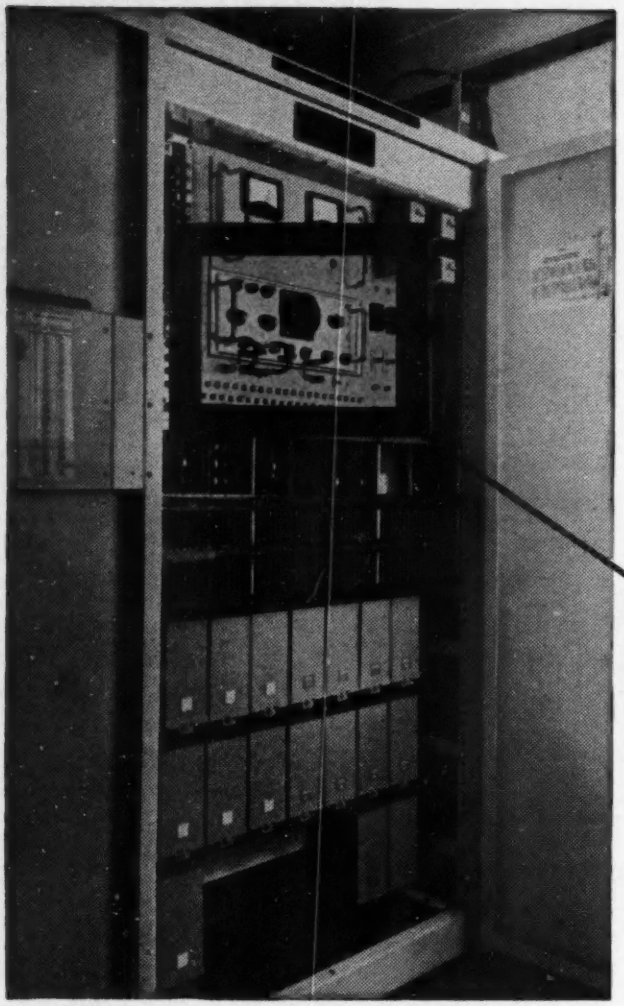

A British Railways photograph

Westronic remote control equipment
for British Railways

WESTINGHOUSE CHOOSE THE SERVISCOPE*

Vital links in the remote-control signalling system on the newly electrified Liverpool Street/ Bishops Stortford line of British Railways Eastern Region are provided by the Westinghouse Brake and Signal Company's Westronic Control and Indication System. Apart from the speed of operation ensured by the continuously scanning code generation method involved, and the long life associated with the all-transistor coding units, the Westronic system is remarkable for its ease of maintenance. Not only are line failures reduced to the minimum by using only one pair of wires to convey command and indication codes between control and field stations, but all coding units take the form of easily accessible plug-in printed circuits. Routine checking of circuits and emergency fault-finding are carried out at the control cubicles, and to speed these vital operations Westinghouse have built a model D.31R Serviscope into each installation.

D.31R is the rack mounting version of the well-known Double Beam Serviscope, used by service engineers throughout the electronics industry in applications such as this, where reliability is essential. All Serviscopes are remarkably small in size, light in weight and low in cost, and in both portable and rack mounting versions have gained an enviable reputation for consistent accuracy even under difficult operating conditions.

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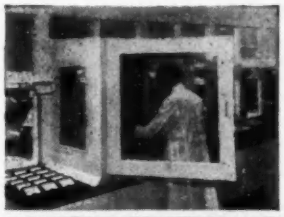

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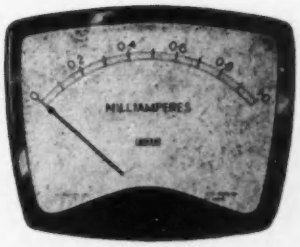

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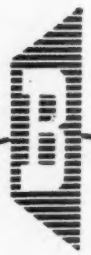

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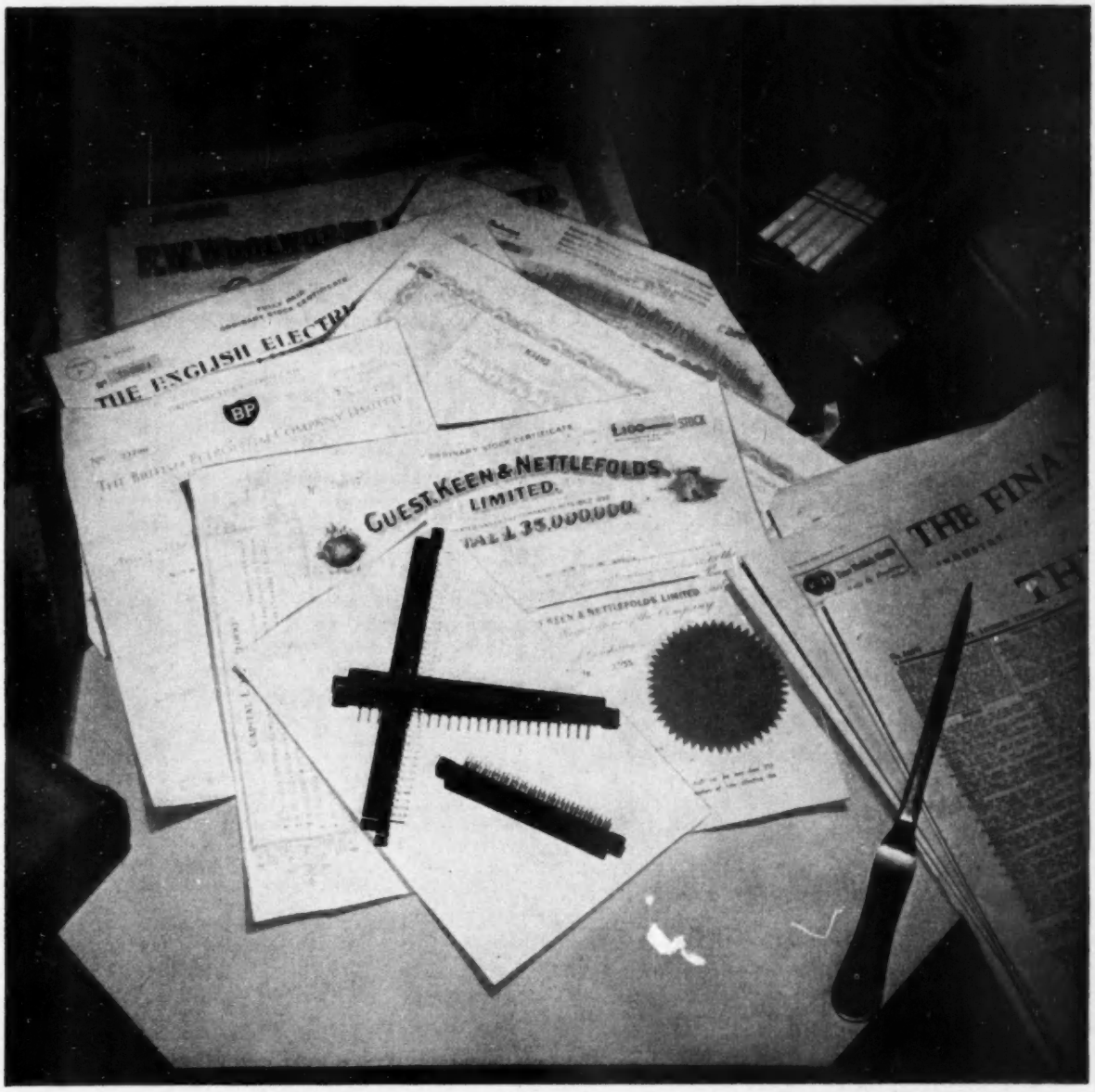

JH&P301

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0.150	0.062	8, 16, 24, 32 & 40	0.200	0.062	16, 32, 48 & 64
0.156	0.062	6, 10, 12, 15, 18, 22 & 27	0.200	0.093	48 & 56
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0.200	0.093	24 & 28	0.156	0.062	36 ways double

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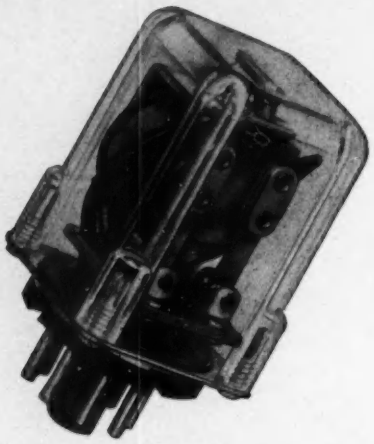
Thorn Pygmy Power Relay



New interchangable relay designed for use in remotely controlled automation units. Has double pole changeover contacts.

Dust proof—transparent plastic cover.

Plugs into any standard International octal valve base.

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Mechanical life over 10,000,000 operations.

Switching current: 5 amps maximum at 250 volts A.C.

Maximum surge current: 10 amps.

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A plug-in relay, particulary suitable for switching P.A. equipment, the snap action contacts minimising interference with pick-up leads.

Operating coil wound for any specified voltage up to 240 volts A.C. or 150 volts D.C. May be tropicalised.

Up to three micro-switch pattern contacts mounted on standard coil frame.

Versions available with up to 11 solder tags or 10 screw terminals.

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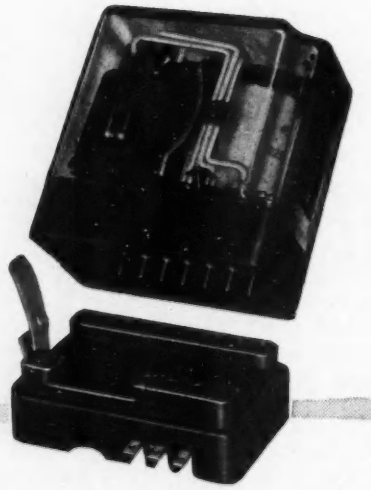
C/O Time:	C.O. period less than 2 milliseconds.
Max. Switch:	10 amps/240 volts A.C. non inductive load.
Capacity:	0.2 amps/240 volts D.C. ,, ,, ,, 0.5 amps/110 volts D.C. ,, ,, ,, 1.0 amps/50 volts D.C. ,, ,, ,, 5 amps/24 volts D.C. ,, ,, ,
Max. Operate Speed:	20 cycles/sec.
Switching Frequency:	Up to 0.1 amp. approx. 20 cycles/sec. ,, ,, 1 ,, ,, 5 ,, ,, ,, ,, 5 ,, ,, 1 ,, ,, ,, ,, 10 ,, ,, 0.1 ,, ,, (referred to A.C. non-inductive load).



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THORN ELECTRICAL INDUSTRIES LTD · SPECIAL PRODUCTS DIVISION
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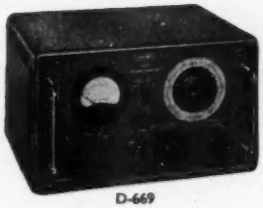
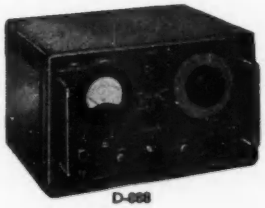
DTV/11

D-469

WAVEFORM ANALYSERS


D-669

with a range of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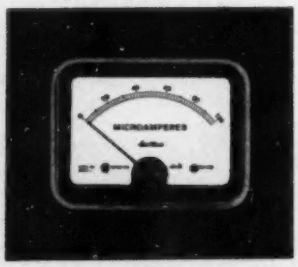

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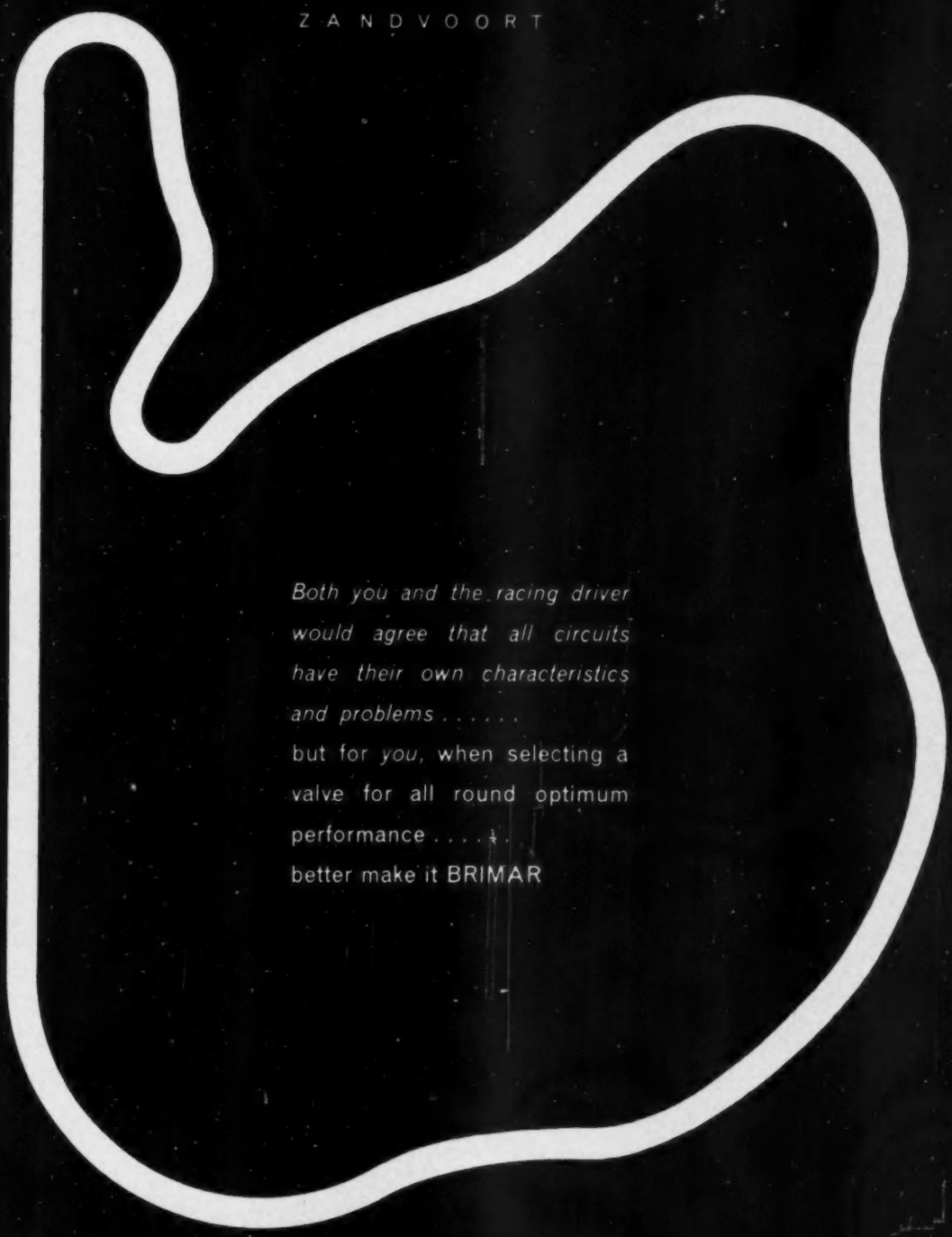

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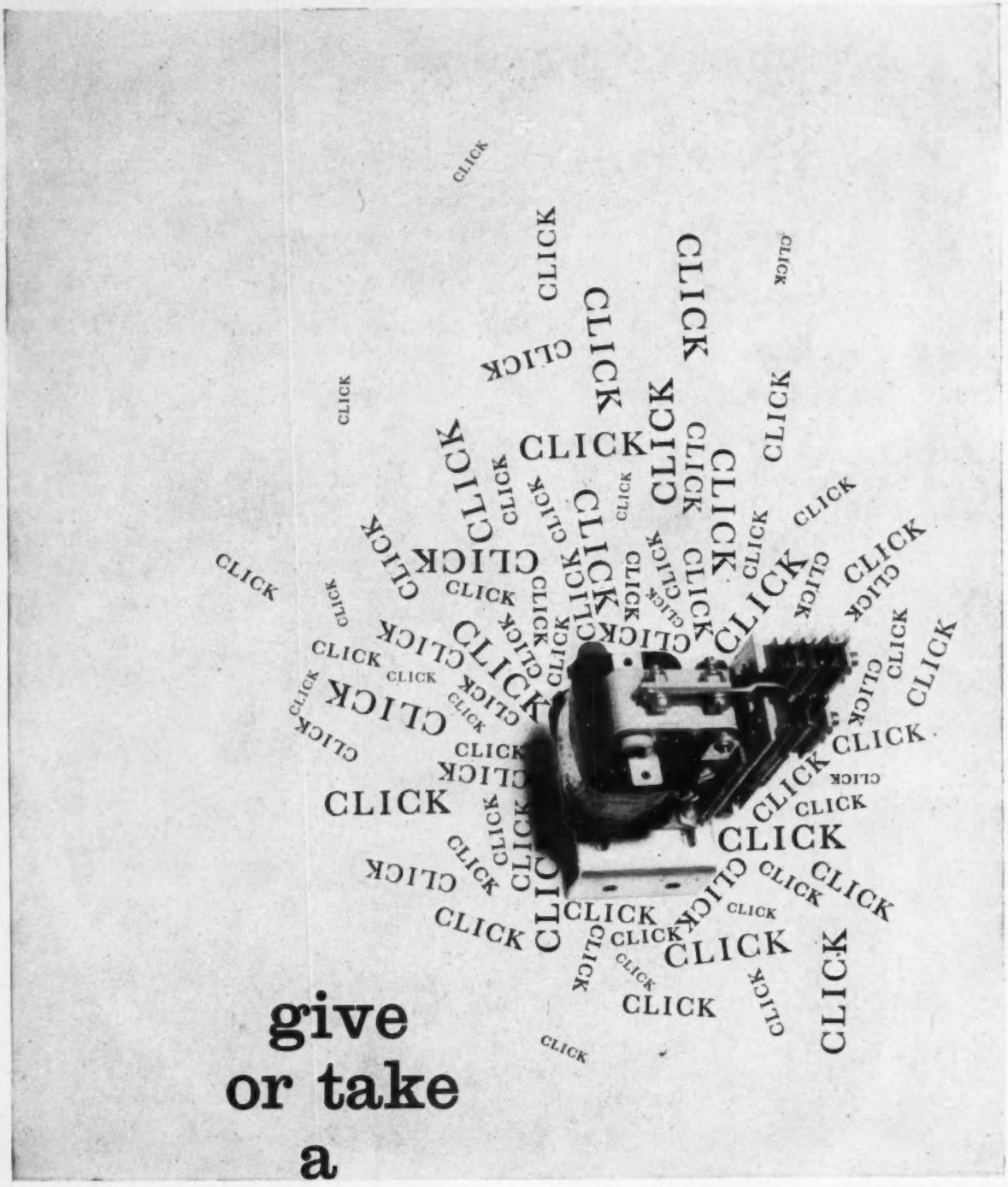

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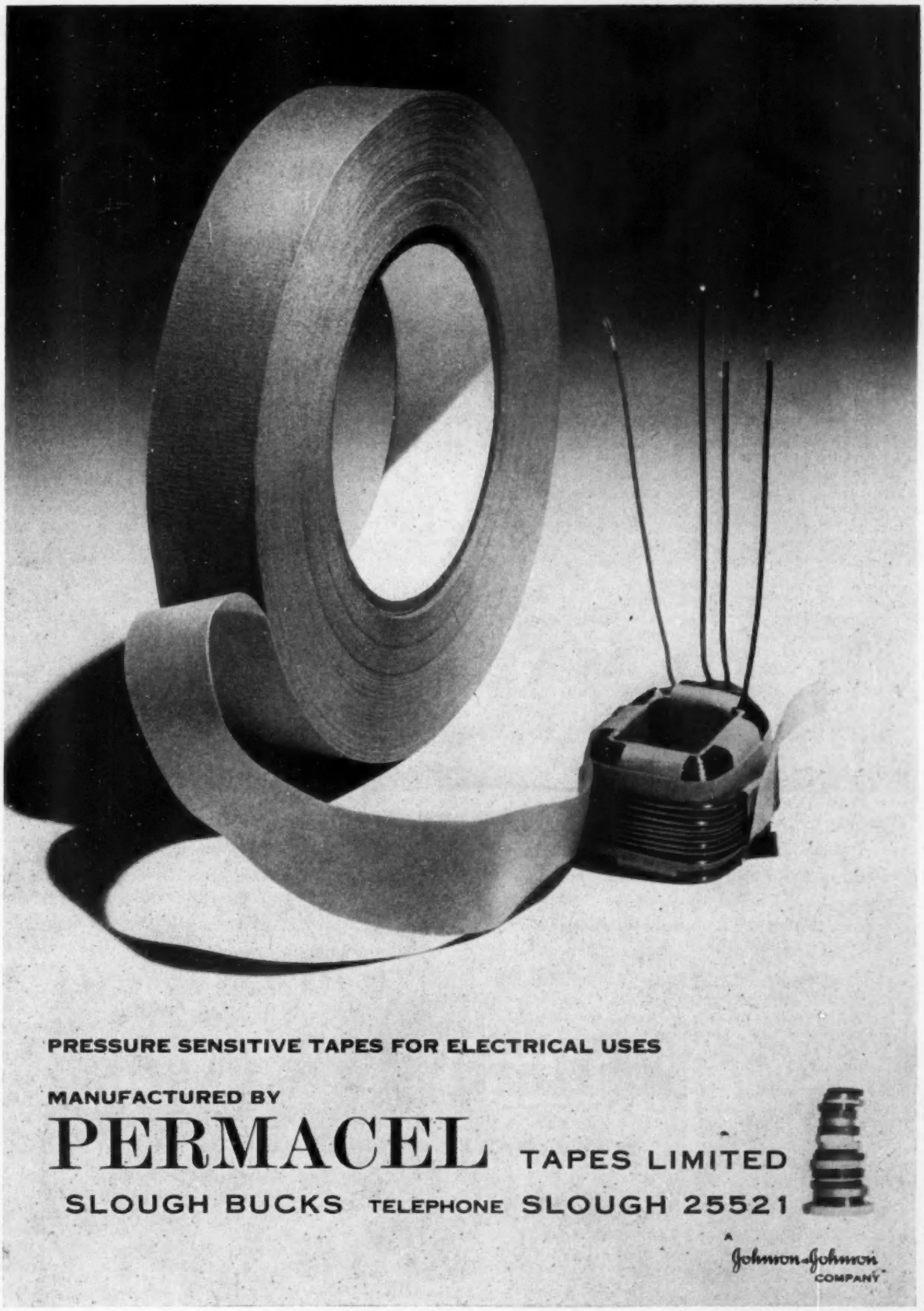
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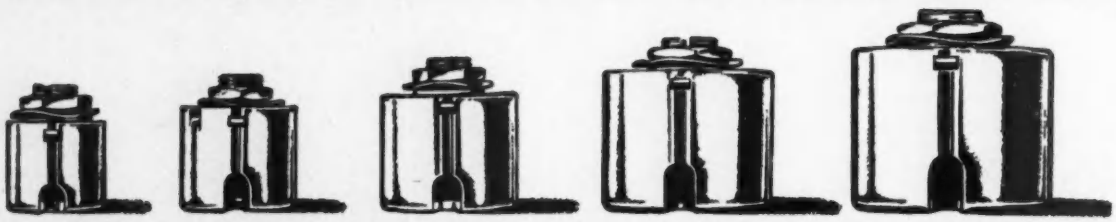
Covers frequencies from 100 Kc/s to 2 Mc/s



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ELECTRONIC ENGINEERING

VOL. 33 No. 399

MAY 1961

Commentary

THE Radio and Electronic Component Manufacturers' Federation published their 28th Annual Report on April 12. The Report shows that although 1960 had its share of ups and downs it was, taken overall, a successful year for the electronic component manufacturers. It will be recalled that during the first few months of 1960 the boom conditions of 1959 continued unabated and there were all the signs of a rapidly expanding economy. Unhappily this rapid expansion revealed a lack of balance and in particular the increase in internal credit was considered too rapid and likely to lead to overspending. To counteract this trend the Government introduced credit restrictions last April followed by an increase in the Bank Rate in June. As was intended, these measures had their greatest effect on consumer goods for the Home Market which, so far as the radio and electronic industry is concerned, means domestic radio and television receivers. Fortunately there was steady expansion in other sections of the electronic industry, particularly in the industrial and instrumentation fields where the increase in output was estimated to be between 10 and 15 per cent. Taken overall therefore, and despite the fall in output of domestic receivers, the industry's output increased in 1960 by about 10 per cent compared with some 6 per cent for the country as a whole.

It is estimated, in the Federation's Report, that the total production in 1960 of professional, domestic and audio equipment, components and accessories and valves and semiconductors had a total value of £400M and that if the electronic output of associated industries was included the total annual output would probably be in the region of £500M. It will of course be appreciated that the compilation of such estimates is somewhat hazardous since the statistical information available is hopelessly inadequate: this is particularly so in the case of industrial electronic equipment.

On the domestic equipment side it is interesting to note that for the first time for five years the number of radio receivers produced was greater than the number of television receivers. This change in emphasis is ascribed mainly to the popularity of the new range of portable transistor receivers and, to a lesser extent, to a growing demand for v.h.f. receivers.

Naturally a large section of the Federation's Report is taken up by the subject of exports and it is gratifying to note that the export of radio and electronic products in 1960 showed an increase of 6·5 per cent over the previous year. With total exports of just over £59M the radio and electronic products group is the largest exporter in the electrical industry and the only major exporting section of the electrical industry to show a substantial increase. Indeed, the exports of the whole electrical industry rose by only 1·5 per cent during the year compared with the National average of 6 per cent.

So far as the radio and electronic group is concerned the major rise in exports was recorded by the component section with an increase from £10M in 1959 to £13·6M in 1960. There were also improved returns for all other sections of the industry with the exception of Capital Equipment which fell by 3·7 per cent and Audio Products which dropped by nearly 6 per cent.

For the group as a whole the principal markets remained relatively unchanged and the U.S.A. again headed the list. In the component section there was, however, a change in the relative precedence of the markets and for the first time Europe displaced the Commonwealth as the largest customer; the most impressive gains were in Norway and Sweden where sales were more than double the previous year's figures.

It would, however, be a grave mistake to become too jubilant about the success of our exports for, while the latter reached the record figure of £59·1M the imports of radio and electronic products rose to the record level of £22·6M: an increase of 9·7 per cent compared with the previous year. In fact while imports have doubled in the last five years exports have increased by only 45 per cent; in other words, during that period, the rate of increase for imports has been more than twice that for exports.

In their Report the Federation make particular reference to the increasing threat from Japanese competition and it is stated that they have submitted to the Government strong representations resisting further concessions to Japan in the U.K. Home Market, principally on the grounds that cheaper labour costs in Japan give that country an unfair advantage in competition with British Manufacturers. That may be all very well so far as our Home Trade is concerned and it may well be that Japan cannot maintain low labour costs indefinitely, in the meantime, however, we have got to face their competition overseas and it is up to us either to produce outstandingly better goods or to use our ingenuity to reduce our production costs to a competitive level and preferably, of course, to do both.

Looked at as a whole the Report is a satisfactory one and the members of the Federation may feel justly proud of their achievements during 1960. It contains, however, a sufficient number of warning notes to prevent undue feelings of complacency and it is apparent that if satisfactory progress is to be maintained there can be no slackening of endeavour in the future.

A READER FOR HAND-MARKED DOCUMENTS

By Cynthia M. B. Reid*, M.A.

A design is described for a simple machine to read hand-marked documents such as invoices. The reasons for undertaking the project are outlined, and problems inherent in sensing marks made by hand described. The mechanical and optical design of the reader is briefly described and a detailed account given of the logical operations whereby the information on the document is sensed, staticized, processed and punched into tape. Built-in alarms minimize the risk of mistakes due to creases or dirt, and their usefulness is indicated in a summary of operational results.

(Voir page 336 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 342)

WHEN the idea of using computers in the offices of J. Lyons & Co. Ltd, was first suggested, it was recognized that the production of the data in a form that could be read automatically would save a great deal of labour. In 1954 experiments started to devise an instrument that would enable a salesman to set out an order for bakery goods in a form suitable for automatic reading.

This problem arises in any business where computers are installed and many suggestions have been made for the automatic recording of data arising from the use of cash registers, adding machines and the like. However, when one is dealing with the production of invoices by salesmen in the field such machines are not usually available and so a form which can be hand marked with pen or pencil is the natural medium.

The problem was considered by the engineering staff of LEO and a specification drawn up for the experimental reader which forms the subject of this article. As a result of the experimental work done with it, an engineered prototype suitable for production is now being designed. The model described is simple, even elementary, as a deliberate policy since it was felt that only by getting actual practical experience of collecting data from salesmen would it be possible to see what design features were important and which not. The simplicity of the current design in no way precludes the introduction later of refinements such as automatic feeding and stacking of the forms.

The Document

A section of the document is shown in Fig. 1. The salesman can order quantities up to 96 of any one item by marking one or more columns. (A space is provided for manuscript amendments or additions.) The squares normally measure $\frac{1}{4}$in × $\frac{1}{4}$in and are marked diagonally from bottom left to top right with a soft pencil, grade HB or B.

On the punched tape the item is identified by the 'item number', shown in Fig. 1 to the right of the marking area. Item numbers 08 and 09, 18 and 19, and so on are omitted so that the numbers are in the octal system, thus the output of a multi-stage binary counter gives the item number directly.

The short horizontal lines in the column on the right are 'location marks' and define the scanning period for each item.

The right-hand edge of the document is taken as a reference; by specifying the distance of the location marks from this edge to an accuracy of ±·005in it is possible to ensure that they pass exactly under the sensing photocell. The positions of the quantity columns must also be specified to the same accuracy and this at first made printing the forms cheaply difficult. Setting up the form in print in the usual way was found not to be sufficiently accurate and was in any case several times more expensive than printing the conventional order form.

The photo-lithographic process was finally adopted and is both accurate and reasonably cheap. The document is drawn twice full-size by a skilled draughtsman. This is reduced photographically during the production of the metal plate positive. The plate can produce many thousands of copies, and when worn out can be replaced for less than £1. Continued accuracy is ensured during printing by checking the position of the location marks occasionally with a simple gauge.

The document is a lengthy one and must therefore be folded before it can be sent through the post. The reader would occasionally sense this fold as information or treat it as a 'doubtful mark' (see below). It was therefore decided to machine-fold the document on a fixed line. Heavy marks are printed in every quantity column on this line, which is then not used for recording information. The computer is programmed to ignore holes punched from the marks on this line. This scheme has proved to be competely satisfactory.

Although it was expected that the salesman would be reasonably careful not to crumple or soil the document badly, it has been found in practice that the reader is tolerant of mild creases or smudges.

Fig. 1. A section of the document

Some specimen marks are shown in the quantity columns. The extreme right-hand column contains the location marks, which define the scan period

Consumer Price	DESCRIPTION		QUANTITY ORDERED 1	2	3	6	12	24	48	Code No.	
9d ctn	KUP KAKES	×3 Chocolate								1	—
9d ctn		×3 Lemon								2	—
9d ctn		×3 Orange								3	—
9d ctn	COCONUT TOASTIES ×3									4	—
3/- ctn	CHOC ROLLS ×12	C.V.F.								5	—
3/- ctn		Jam								6	—
3/- ctn	MILK CHOC ROLLS ×12	C.V.F.								7	—
3/- ctn		Jam								10	—
2/- ea	COCONUT SNOW CAKES									11	—
1/8 ea	LARGE SWISS ROLLS	Raspberry								12	—
1/8 ea		Apricot								13	—
1/6 ctn	TARTS	×6 Jam (Asstd. Flav.)								14	—
1/9 ctn		×6 Assorted								15	—
1/9 ctn		×6 Blackcurrant								16	—
1/9 ctn		×6 Alm'd Bakewell								17	—
1/4 ctn		×6 Treacle								20	—

* *LEO Computers Ltd*

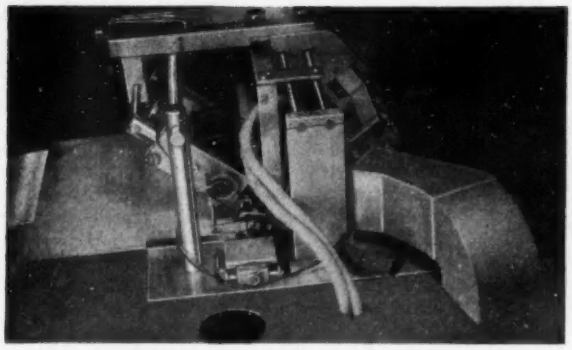


Fig. 2. View of the reading head

In the centre foreground is the plate armature which operates the brake/drive shaft, visible just beyond it. On the right is one of the cooling nozzles

Mechanical and Optical Arrangement

The form is fed at 10in/sec by two spring-loaded jockey rollers which force it into contact with driven rollers in continuous rotation, which just protrude through the deck of the reader. The jockey rollers are fitted to the end of a short rocker, at the other end of which are brake pads for stopping the form by pressing it against the surface of the deck. The rocker shaft is rotated between 'run' and 'brake' positions by two solenoids. A common armature is rigidly attached to the rocker shaft (see Fig. 2). The solenoids are driven from a bistable circuit so that one or other is always actuated.

The form travels between accurately spaced guides and passes beneath a horizontal metal plate just far enough above the deck to allow free running. This tends to flatten creases in the paper which might otherwise produce spurious pulses. A long 'window' $\frac{1}{4}$in wide is cut in this plate allowing the reading section of a line to be visible.

The area of the window is strongly illuminated by four 44W lamps having axially mounted filaments and mounted in pairs on both sides of the window and with filaments parallel to it. It is essential that these lamps are fed from a d.c. supply since a.c. would cause fluctuations in light intensity. The light incident on the window has an average angle of 45° to the vertical from either side. Behind each pair of lamps is an elliptical mirror. The positions are carefully adjusted so that the lamp filaments lie along the first focus of their mirror, and the centre of the window lies along the second focus of both mirrors. (See Fig. 3.) This arrangement throws a concentrated strip of light on the area being sensed.

The reading cells are mounted in a metal block above the window; in one version of the reader there is a cell over each of the seven quantity-columns on the document, and one over the location mark column, making eight cells in all. A later model has fifteen cells. A pair of plano-convex lenses focuses the area being sensed via a slit on to the sensitive area of an OCP71 photo-transistor. (See Fig. 4.) The system is adjusted so that the lower lens has its focus on the document and the upper lens has a focus coinciding with a slit in a piece of metal foil. This slit is of the same width and direction as a correct mark on the document, so that when a mark is sensed, its image coincides with the slit, cutting down the light to the OCP71 above it.

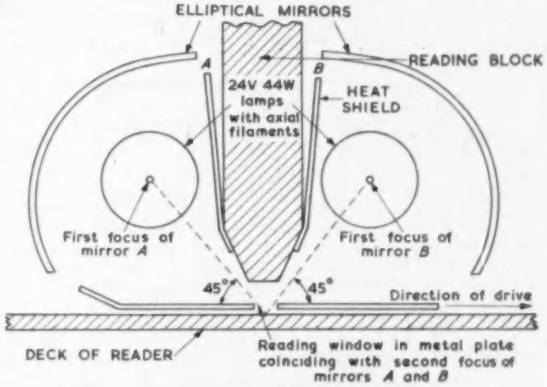
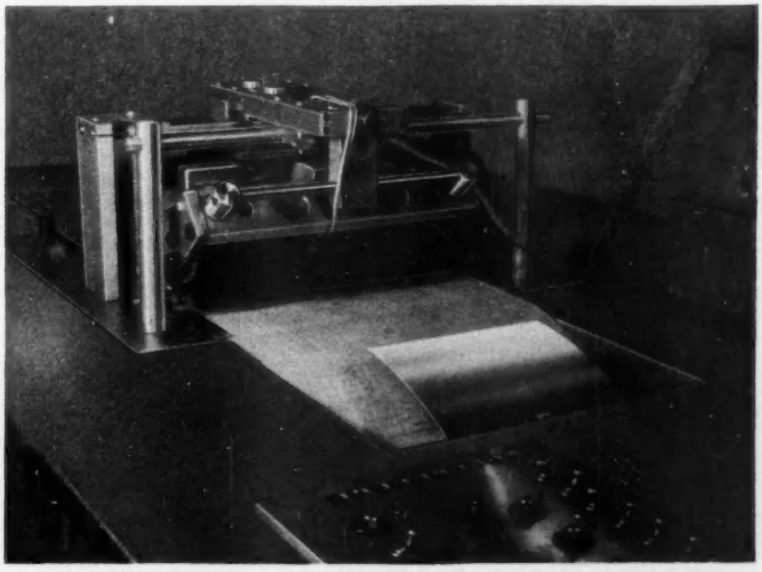


Fig. 3. The optical arrangement

The arrangement of lamps and mirrors, shown here in cross-section, gives a concentrated strip of light at the reading window. The heat shields protect the reading block from the direct heat of the lamps

The maximum sensitivity of the OCP71 occurs in the infra-red region, but it is found that a black pencil mark cuts off enough of the infra-red light to give a good pulse at the collector.

The reading head is between the lamps and must therefore be cooled. A fan drives air through nozzles directed at the reading head which is further protected from direct



The photograph shows the general view of the deck

In the foreground is the control panel, and on the right can be seen the punch and tape

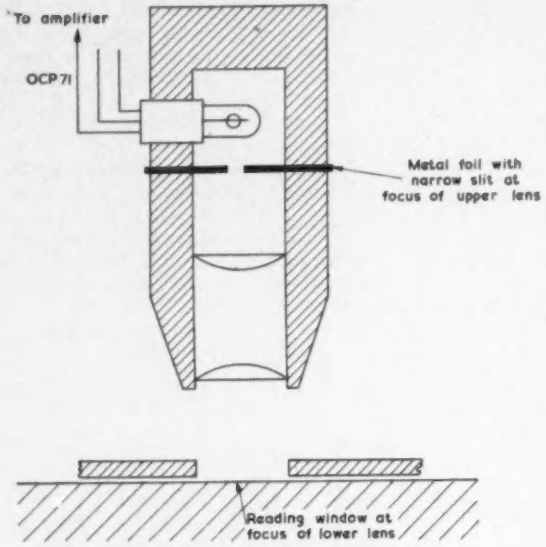


Fig. 4. Reading cell

Eight of these cells are situated one above each quantity column and one above the location mark column. Any reasonable mark on a sensing square will cast an image on the slit, cutting down the light on the OCP71 and producing a pulse at the collector

heat by metal shields placed between it and the lamps.

The valves and circuit components are mounted on five standard LEO units[1] which can be quickly removed. Each unit contains an average of twenty-five valves, most of which are E88CC double triodes.

Operation of the Instrument

After switching on, the operator presses the initial reset button which sets all bistable circuits in the correct initial state. She then releases a loading lever which allows the jockey rollers to drop on to the document. The initial reset button has already put the drive/brake circuits into the 'drive' state so that the document now starts to move forward.

Whenever a mark in a particular column passes under a photo-transistor a negative pulse appears at its collector. The pulse is reversed and amplified by a photocell amplifier, of which there is one for each of the eight photocells. The output of the amplifiers corresponding to the seven quantity columns is applied to a storage gate, connected, via a register input gate, to the set input of the appropriate flip-flop register (see Fig. 5).

The output of the location-mark photocell amplifier is squared by a Schmitt trigger circuit whose output is applied to a binary counter, the scan-period counter. Each row of the document has two 'location marks' so that the scan period counter, initially in the '0' state, will be in the '1' state for the period of time between the pair of location marks, which will be referred to as the scan period. Throughout the scan period the seven information storage gates are primed, so that the maximum output voltage of each photocell amplifier will be held on the storage gate capacitor whose leakage time-constant is much greater than the scan period.

At the end of the scan period, the register input gates open and if any storage gate has an output voltage of over 20V, its flip-flop register will be set. Setting a register causes the corresponding storage gate to be rapidly discharged via the reset output of the register concerned.

In Fig. 5, only two of the information routes are shown, the remaining five being identical.

Punching the Information

The set outputs of the seven information registers are fed to an OR gate to produce a 'punching required' condition if any register is set (Fig. 5). The 'punching required' condition will cause the document to stop and will also trigger the reperforator so that punching can occur. Each row of the document corresponds to five rows of punched tape which contain information as follows:—

(a) Row 1 carries the item quantities 12, 24 and 48 which are punched in the tape columns '1', '2' and '4' respectively (Fig. 6).

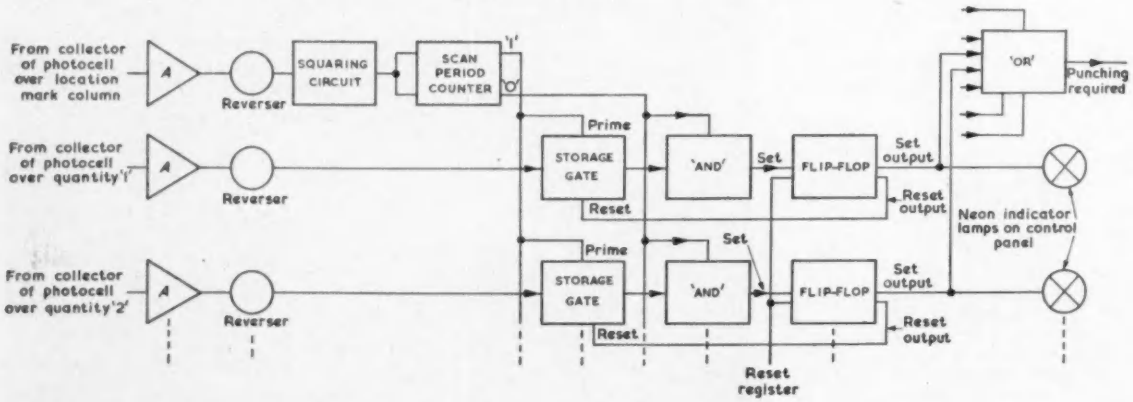
(b) Row 2 carries the item quantities 1, 2, 3 and 6 which are punched in the tape columns '1', '2', '4' and '8' respectively.

(c) Row 3 carries the more significant figure of the item number obtained directly from the '1' outputs of the multi-stage line counter.

(d) Row 4 carries the least significant figure of the item number.

Fig. 5. Staticizing the information

Only two of the seven information channels are shown, the remaining five are identical with these



On each of these four rows a hole in the '16' position indicates that the rows carry numerical information.

(e) The fifth and last row punched for this line on the form has holes in the '2' and '4' positions. This code represents block end to the computer and conveniently divides the punchings for that line from the next group of punchings.

This simple one-to-one correspondence between the position of the information on the document and the position of the hole representing it on the tape gives the machine great flexibility, since the quantity columns may have any value appropriate to the application considered. A slight change to the programme used by the computer caters for the change of quantity.

After punching block end all registers are reset and store gates discharged in case any retained a residual

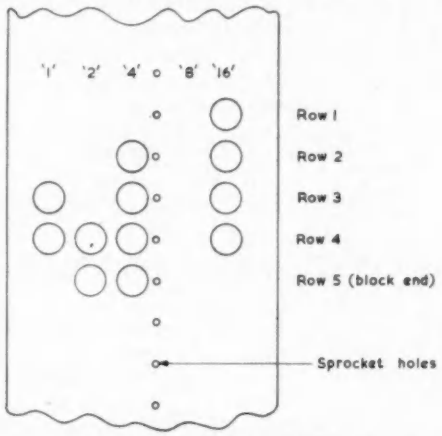


Fig. 6. Layout of punched information on the tape
A section of tape is shown, punched as described in the text. This corresponds to a quantity 3 sensed on document line 57

voltage. The document drive is then restarted and continues until the 'punching required' condition occurs again.

Evidently to control the tape punch, the output circuits must know which of the five rows in the tape cycle is about to be punched. This involves a three stage binary counter which is set in the state 0, 0, 1 by the initial reset button, and is stepped after each row of tape has been punched, by a synchronizing pulse mechanically produced by contacts in the reperforator. After punching the fifth row of the cycle the counter is required to begin again, i.e. to return to the state 0, 0. 1. To do this, the condition 'tape row five' is effectively reversed to close the input gate to the three-stage tape row counter and prevent the synchronizing pulse from stepping on the counter from 1, 0, 1 to 1, 1, 0. At the same time the condition 'tape row five' allows the synchronizing pulse to pass through another gate to set the counter directly to the state 0, 0, 1 the required position.

To see how the flow of information is controlled assume that quantity 3 is marked on a particular line of the document. In this case the condition 'punching required' causes the document to stop and triggers the reperforator which is ready to punch 'tape row one'. There is no information on this row since the quantities 12, 24 and 48 are not marked. Thus the first tape row contains a hole in the '16' position only, indicating a numerical zero (see Fig. 6). The synchronizing pulse then steps the tape row counter to the state 'tape row two'. This condition is gated with the set output of the register, corresponding to quantity three in one of the fourteeen information-routing AND gates. This gate will thus give an output which passes through an OR gate to call the punch corresponding to tape column '4'. Thus the second row of the tape contains holes in the '4' and '16' positions. If the document line number were say 57, then the third tape row would show a five in binary code (i.e. hole positions '1', '4' and '16'. This is obtained directly from the document line counter. Similarly the fourth tape row would contain holes in the '1', '2', '4' and '16' positions.

For the fifth row of the cycle, the condition 'tape row five' appears and is passed directly through the two OR gates feeding the punches for tape columns '2' and '4', this being invariable and giving the block end at the end of each five row cycle.

The Doubtful Mark Alarm

The 20V signal needed to set a register, is set up to correspond to a reasonable mark on the document, viz

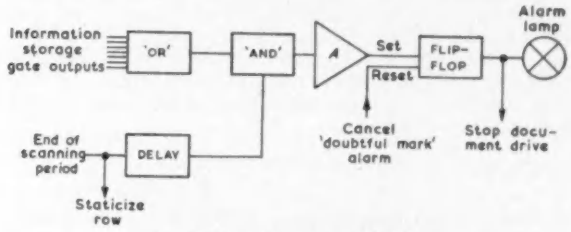


Fig. 7. The 'doubtful mark' alarm
If any storage gate has an output between ten and twenty volts, the flip-flop will be set, the alarm lamp will light, and the document will be halted

one made by a 2H pencil with moderate pressure or by an HB pencil with slight pressure. Creases or dirty fingerprints would not normally produce a 20V signal but might give 12 to 15V. Further, if the marks were inaccurately or too lightly made, the signal might be only 12 to 15V. Clearly the reader will be unable to distinguish between a poor mark and a fingerprint if both give a signal of 15V. For this reason a 'doubtful mark" alarm circuit has been incorporated.

The outputs of all information storage gates are mixed together and tested at a time sufficiently long after the end of the scan period to ensure that any stored information will have been discharged, by the reset output of the information flip-flop (see Fig. 7). The sensitivity of the flip-flop registering a doubtful mark is adjusted so that if any storage gate still holds between 10 and 20V it will be set during this test.

Setting the 'doubtful mark' flip-flop lights an alarm on the control panel and stops the drive so that the operator knows immediately that a doubtful mark has been sensed. She then observes in the reading window the line of the document being scanned, and compares the marks on the document with the state of the registers. If all the intended marks have been staticized, the alarm must have been due to a crease or smudge and the operator can cancel the alarm by push-button. If, however, any of the intended marks have not been staticized she must remove the document and improve the poor marks before reloading. In this case she must punch a special pattern on the punched tape to indicate that the information already punched for that document is to be disregarded. This is also done by a single push-button, the 'tape cancel' button.

The 'Wrong Count' Alarm

Before starting the run, the operator sets up, on a bank of switches on the control panel, the total number of lines on the document. As reading proceeds the multi-stage binary counter stepped by the '1' output of the scan period counter counts the number of lines scanned. The location marks for the last line are wider apart than the others so that the scan period is much longer. This is detected by an integrating circuit when the last line has been reached. The number set up by the operator on the switches is then automatically compared with that on the line counter.

If the numbers agree the reading channels are closed and the document will run out to the stacking tray without any further reading. At the same time two inches of blank paper tape are produced to give a visual indication on the tape of the end of form.

If, however, the numbers do not agree the document stops on the last row and a 'wrong count' alarm lamp lights on the control panel. The operator may then check the number set on the switches. Correction of a faulty setting will cancel the alarm and allow the document and tape to run out as before. If the switches have been set correctly, the reader must have miscounted, and the operator may press initial reset and tape cancel buttons and examine the location mark column for badly printed location marks, or creases.

Cancel Facility

From the outset it was recognized that it would be very useful if information already marked on the document by a salesman could be cancelled by him. In practice it is found that this facility is used on nearly every document containing twenty or more orders.

Obviously marks could be erased with a pencil eraser, but this is liable to leave enough surface roughness and graphite on the document to give a doubtful mark alarm. Another method which has been tried is to design the computer programme to disregard the quantity ninety-six corresponding to a mark in every quantity column. This method has the disadvantage that if any of the marks were entirely missed by the reader, the remaining marks would constitute an order for several dozen. This could be overcome by a scrutineer who would quickly examine all the documents for such faults. Taking this precaution the method is quite satisfactory, but a further method is available.

An extra column, the 'cancel' column is included on the document with its own photocell, amplifier, storage gate and register. However the register set output is not regarded as information to be punched, but is reversed to inhibit the 'punching required' condition. Thus when a 'cancel' mark is sensed on any document row the document does not stop and no punching occurs. This method has been used and proved very satisfactory although again a scrutiny of the document is needed in case there are any poor cancel marks.

Operational Results

The document reader completed a six months trial run during 1959, during which several modifications were made to improve the reliability and accuracy. Following this the reader underwent a 'soak test' in which it read documents continuously for two days. The total number of marks on the documents was 66 000 of which 65 781 were punched and the remaining 219 gave doubtful mark alarms; in a total of 66 000 marks not one was missed. A fully engineered version tested over a longer period would be expected to give even higher performance. The present model includes marginal testing facilities as in the LEO computers[2], to guard against the possibility of valve or component drift, and a facility for reducing the intensity of illumination of the document by ten per cent. These tests give the engineer an early warning of impending failure.

It will be apparent that the design of the reading head and circuits is such that they could be altered to cope with differences in such things as the quantity significance of the various columns, or the size of the marking areas. In fact one user might be able to find several uses for a single reader with quickly detachable reading head and logic interchangeable by switch which could thus deal with several different styles of document.

Acknowledgments

Acknowledgments are due to Dr. J. M. M. Pinkerton and Mr. J. Bruce for help and advice in the preparation of this article and to LEO Computers Ltd for permission to publish it.

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2. Lenaerts, E. H. LEO. Operation and Maintenance. *Electronic Engng. 26*, 337 (1954).

High Voltage Switching with Transistors*

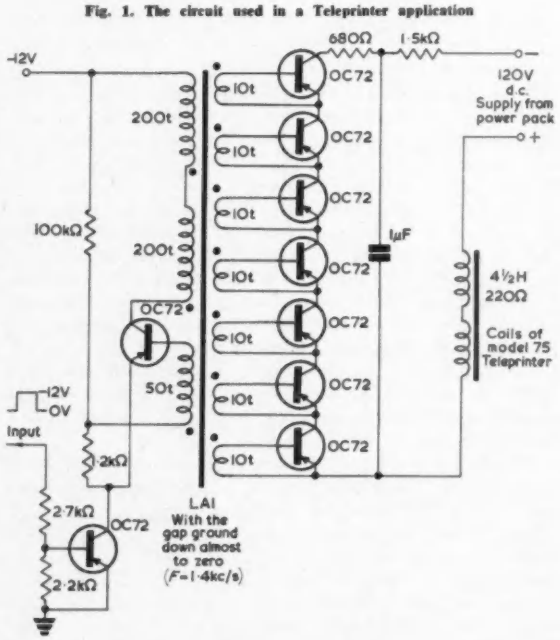
The circuit of Fig. 1 shows a method of switching a high voltage by means of low voltage transistors. The circuit consists of three parts.

(1) A ringing-choke d.c. convertor which oscillates only when pulsed by the input switching signal.

(2) A stack of low voltage transistors which are 'off' when the convertor is not oscillating and 'on', and thus offering an intermittent short-circuit, when the convertor is energized.

(3) A filter circuit.

Fig. 1. The circuit used in a Teleprinter application



* *A communication from E.M.I. Ltd.*

Long-Distance Waveguide Transmission

By R. Hamer*, Ph.D., A.M.I.E.E.

(Part 2)

(Voir page 265 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 272)

A Practical Waveguide Structure

As already discussed, a practical waveguide structure must have the internal surface impedance offered to the various propagating modes modified so as to:

(a) Remove the equality of phase velocities of the H_{01} and E_{11} modes.

(b) Increase as much as possible the attenuation coefficients of all modes except the H_{01}.

It is not possible to obtain a surface impedance that will increase the attenuation coefficient of the H_{0n} waves appreciably more than that of the H_{01} wave. Apart from this, however, both the above requirements can be met in two ways of practical importance:

(1) By the use of a ringed or helical structure.

(2) By coating the internal surface of a smooth metallic waveguide with a thin film of lossy dielectric.

Although the analysis so far described is of general application in f.m. waveguide systems, there is considerable complexity in applying the results to a particular waveguide structure. For this reason attention will be confined to one particular structure and since work is proceeding in many countries on helical structures[17], the dielectric lined waveguide has been chosen for further examination here.

It has been shown that with given modulation characteristics the n.p.r. at the end of a long waveguide system is dependent on the values of $\Delta\alpha$ and $\Delta\beta$ for each parasitic mode. The curves in Figs. 2 and 3 show that $\Delta\alpha$ should be as large as possible and $\Delta\beta$ as small as possible (u large); however, $\Delta\beta_{E11}$ must be large enough to avoid E_{11}-mode degeneracy, and the larger $\Delta\beta$ for all modes the smaller is the parasitic-mode power generated by distributed imperfections. The relationship between the values of $\Delta\alpha$ and $\Delta\beta$ and the type of dielectric lining will now be considered.

The effect of a dielectric film is to increase the surface impedance of the internal waveguide wall. The increments in the attenuation and phase constants are approximately as follows[18].

H_{mn} waves

$$\left.\begin{aligned}\delta\alpha_{mn} &= (1/s)\,\frac{\lambda_o\lambda_g}{\lambda_c^2}\,\frac{1}{1-(m^2/\chi_{mn}^2)}\left(R_\phi+\frac{\lambda_c^2}{\lambda_g^2}\,\frac{m^2}{\chi_{mn}^2}\,R_z\right)\\ \delta\beta_{mn} &\text{ is the same with } X_\phi \text{ in place of } R_\phi \text{ and } X_z \text{ in place of } R_z\end{aligned}\right\} \quad (14)$$

E_{mn} waves

$$\left.\begin{aligned}\delta\alpha_{mn} &= (1/s)\,(\lambda_g/\lambda_o)\,R_z\\ \delta\beta_{mn} &= (1/s)\,(\lambda_g/\lambda_o)\,X_z\end{aligned}\right\} \quad (15)$$

where λ_o = free-space wavelength,

λ_g = guide wavelength of mode considered,

λ_c = cut-off wavelength of mode considered,

$Z_\phi = R_\phi + jX_\phi$ = circumferential surface impedance, normalized to 377Ω,

$Z_z = R_z + jX_z$ = longitudinal surface impedance, normalized to 377Ω,

and other symbols are as already defined.

When the surface impedance is modified by means of a dielectric film, there is an extra increment in the attenuation constant due to the concentration of the tangential component of the electric field near the waveguide wall. It has been shown by Unger[19] that if the film is very thin this is, for H_{0n} waves:

$$\delta\alpha' = (\lambda_c^2/\lambda_o^2)\,\chi_{0n}^2\,(t^2/s^2)\,\alpha_{0n}\,(e-1) \quad \ldots\ldots \quad (16)$$

where t = dielectric film thickness,

e = relative permittivity of dielectric,

α_{0n} = H_{0n}-mode attenuation constant in plain waveguide.

The increment $\delta\alpha'$ is very small and, over the ranges of permittivity and thickness considered here, the increase in the H_{01}-mode attenuation is unlikely to exceed 1 per cent.

When the film thickness is very small compared with the waveguide radius, the surface impedance in highly overmoded waveguide is related* to the properties of the dielectric film as follows[7,20,21]:

$$Z_\phi = \tfrac{1}{2}\,(2\pi t/\lambda_o)^2\,e\tan\delta + j\,\tfrac{1}{2}\,(2\pi t/\lambda_o)^2\,(e-1) \quad \ldots. \quad (17)$$

$$Z_z = (2\pi t/\lambda_o)\,(\tan\delta/e) + j\,(2\pi t/\lambda_o)\,(1-(1/e)) \quad \ldots. \quad (18)$$

where $\tan\delta$ is the loss tangent of the dielectric. It may now be seen that $\delta\alpha_{mn}$ is determined by both the permittivity and loss tangent of the dielectric, whereas $\delta\beta_{mn}$ depends only on the permittivity. Moreover, evaluation of equations (14), (15), (17) and (18) shows that with practicable film thicknesses, in 2in diameter waveguide at frequencies of tens of gigacycles per second, R_ϕ and X_ϕ may be neglected, except for the H_{0n} modes. It may therefore be concluded that a suitable choice of a thin lossy dielectric film should enable the desired values of differential attenuation and phase constant to be obtained, although large increases in $\Delta\alpha_{02}$ and $\Delta\alpha_{03}$ are not possible.

The effect of the dielectric film on the differential phase constants is first considered. Examination of equations (14), (15) and (18) shows that significant changes in the phase constant can be produced only for the E modes (of which only the E_{11} is of interest here) and for H modes higher than H_{2n}. Of these H modes, only the H_{31} is of interest, not because it is a likely parasitic mode, but because a small increase in β_{31} can bring it into coincidence with the phase constant of the H_{01} mode. This would introduce a new degeneracy and must consequently be avoided. The values of $\Delta\beta$ for the E_{11} and H_{31} modes for four values of permittivity, over a range of film thicknesses, are shown in Fig. 5, for 2in diameter copper waveguide at 35Gc/s. If $\Delta\beta$ = 0·5rad/m for either mode is

* General Post Office Engineering Department.

* The results of Malin are in error by a factor of 2.

taken as an absolute minimum value, the values of e and t should be such as to avoid the shaded forbidden region in Fig. 5.

The effect of the dielectric film on the differential attenuation of the parasitic modes is now considered, and, in order to render the problem manageable, it is necessary first to specify a tolerable increase in the H_{01}-mode attenuation. It is here proposed to allow a 20 per cent increase in α_{01} due to the effects of dielectric loss as predicted in equation (14), the new value of α_{01} for computing $\Delta\alpha$ being then 0·000264. The small additional attenuation in accordance with equation (16) will be neglected.

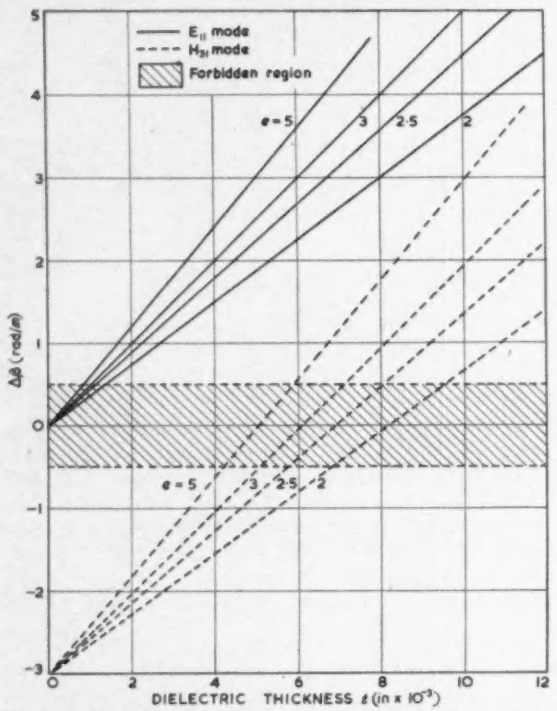


Fig. 5. Variation of $\Delta\beta$ for E_{11} and H_{21} modes in 2in diameter waveguide at 35Gc/s

Solid lines: E_{11} mode. Dashed lines: H_{21} mode. Relative permittivities shown against lines. Forbidden regions ($|\Delta\beta| < 0{\cdot}5$) shaded

From equation (14), some of the H_{on} attenuation increments in 2in diameter waveguide at 35Gc/s are:

$$\delta\alpha_{01} = 1{\cdot}70\,R_\phi$$
$$\delta\alpha_{02} = 6{\cdot}07\,R_\phi$$
$$\delta\alpha_{03} = 14\,R_\phi$$

The characteristics of the various modes are shown in Table 3, and from the appropriate attenuation coefficients it follows at once that for a 20 per cent increase in α_{01}:

$$R_\phi = 2{\cdot}59 \times 10^{-5}$$

and,

$$\left.\begin{aligned}\Delta\alpha_{02} &= 0{\cdot}00067\text{N/m}\\ \Delta\alpha_{03} &= 0{\cdot}0019\text{N/m}\end{aligned}\right\} \ldots\ldots\ldots\ldots\ldots\ldots (19)$$

where $\Delta\alpha_{mn}$ is the attenuation coefficient of the parasitic mode considered relative to that of the H_{01} mode. Thus, for these two modes the differential attenuation is known as soon as the tolerable increase in H_{01}-mode attenuation is specified, irrespective of the dielectric properties determining R_ϕ.

For the remaining parasitic modes it is convenient first to examine the relationship between the permittivity, loss tangent and thickness of the dielectric film consequent upon the choice of a 20 per cent increase in α_{01}. This relationship is obtained from equation (17) by inserting the value of R_ϕ, and in 2in diameter waveguide at 35Gc/s it is:

$$\tan\delta = (12/et^3) \quad [t \text{ in in.} \times 10^{-3}] \ldots\ldots (20)$$

Curves of $\tan\delta$ against t for four values of e are shown

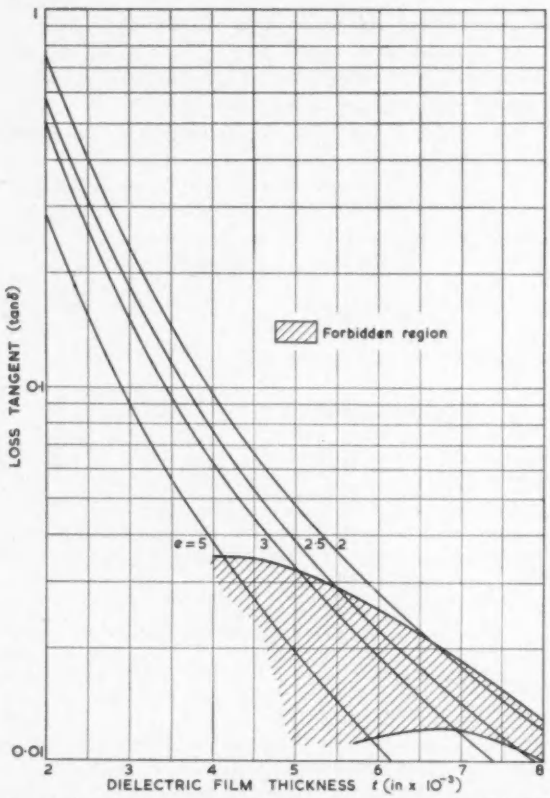


Fig. 6. Variation of tan δ, e and t for a 20 per cent increase in H_{01}-mode loss

Forbidden region hatched. Relative permittivities shown against curves

in Fig. 6. Superimposed on these curves is one of the forbidden regions disclosed in Fig. 5.

It is now necessary to determine the increments in the attenuation coefficient of the remaining parasitic modes in terms of the permittivity and thickness of the dielectric. This is carried out using equation (14) (R_Z term only), and equations (15), (18) and (20), and the results are shown in Table 5.

TABLE 5.

Increments in Attenuation Coefficients

MODE	$\delta\alpha_{mn}$ (t in in. $\times 10^{-3}$)
H_{11}	$3{\cdot}86/e^2t^2$
H_{12}	$0{\cdot}307/e^2t^2$
H_{21}	$6{\cdot}55/e^2t^2$
E_{11}	$9{\cdot}0/e^2t^2$

From the normal attenuation coefficient given in Table 3, the above expression for the H_{12} mode has been plotted as curves of $\Delta\alpha$ against t, for four values of e, in Fig. 7.

The forbidden values already referred to are indicated by the dotted portions of the curves.

From the curves in Figs. 2, 3, 6 and 7, equations (19) and the data in Tables 2, 3 and 5 it is now possible to relate the n.p.r. at the end of the postulated long waveguide to the r.m.s. modulation index, for permissible and practical values of e, t and $\tan\delta$. The relative permittivity and loss tangent of a dielectric, including a composite material obtained, for example, by loading a dielectric with lossy particles, cannot be freely chosen. Comparatively large loss tangents are associated with large permittivities, and this limits the increment that can be achieved in the attenuation coefficient of a parasitic mode. The most troublesome parasitic modes are the H_{12} and H_{02}, of which only the former is appreciably affected by the dielectric film. It transpires that with practical lossy dielectrics the

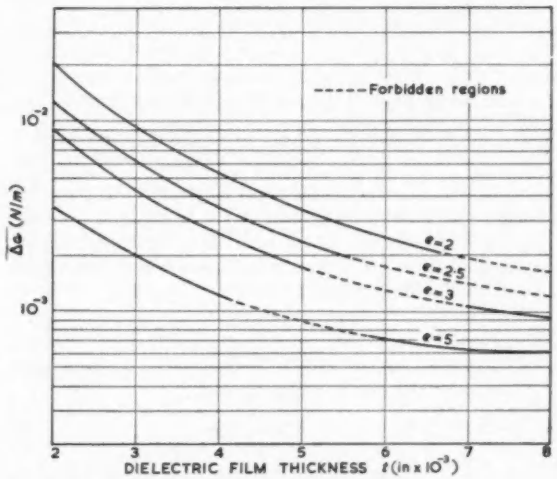


Fig. 7. Relative attenuation of H_{12} mode, with 20 per cent increase in H_{01}-mode loss

waveguide performance is limited almost entirely by H_{12}-mode parallel-flow.

The n.p.r. in a simulated 2 700-channel system at the end of a 280km run of waveguide is shown in Fig. 8 for three practical dielectric linings. The curves display a minimum n.p.r. with modulation indices in the region 0·7 to 1, indicating the desirability of operating with $m \ll 1$ or >1. The probable best attainable dielectric (curve (a); $e = 3$, $t = 2 \times 10^{-3}$in, $\tan\delta = 0{\cdot}4$) should enable a n.p.r. of about 50dB to be obtained with $m = 0{\cdot}4$ or 5. The performance recommended by the C.C.I.T.T. is such that the n.p.r. taking into account all noise sources should exceed 42dB, so a value of some 45dB due to intermodulation noise alone is necessary. The n.p.r. due to parallel-flow in the waveguide should therefore exceed about 48dB to allow a reasonable margin for other sources of intermodulation noise. It would appear that this performance may be just realizable in a f.m. system utilizing a dielectric lined waveguide.

Dispersion

Even in highly overmoded waveguide, significant dispersion occurs, and the group-delay/frequency characteristic is therefore non-uniform. This problem has been examined by Larsen[22], who also describes methods of equalization.

Group-delay distortion is a serious problem in f.m. transmission and will require careful equalization over the transmission band of each carrier wave. It is unnecessary to consider continuous equalization over the whole of the frequency band utilized; group-delay non-uniformity cannot produce intermodulation distortion between the modulating signals borne by separate f.m. carriers, such as might be used in a long-distance waveguide system. (Amplitude non-linearity in mutli-carrier amplifiers in the waveguide system would, however, cause such distortion*, but this problem is outside the scope of the present investigation.) If it is assumed that separate r.f. carriers, each bearing a 2 700-channel f.d.m. signal, are used, then group-delay equalization over each separate transmission band of 50 to 100Mc/s (depending on the modulation index used) would be required.

The transmission group-delay per metre of the H_{01} wave in circular waveguide is:

$$T_g = (\omega/v_0)(\omega^2 - \omega_c^2)^{-\frac{1}{2}} \quad \ldots\ldots\ldots (21)$$

where ω = angular frequency

ω_c = angular cut-off frequency.

Over relatively small frequency bands the variation is substantially a linear slope, and the differential delay reduces

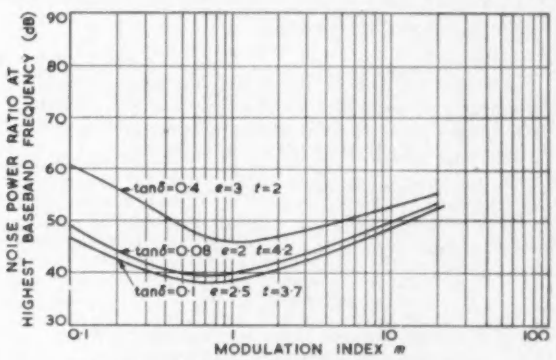


Fig. 8. N.P.R. in 280km 2 700 channel system

to the following:

$$\delta T_g = (f_c^2/f_0^3 v_0)(f - f_0) \quad \ldots\ldots\ldots\ldots (22)$$

where δT_g = group-delay per metre relative to that at the frequency f_0,

f_c = waveguide cut-off frequency.

In 2in diameter waveguide at 35Gc/s the following important result follows, for the group-delay slope:

$$(dT_g/df) = 4{\cdot}04 \times 10^{-6}\text{nsec/(Mc/s)} - \text{m} \quad \ldots. (23)$$

Over a 280km route this becomes:

$$(dT_g/df) = 1{\cdot}1\text{nsec/Mc/s}$$

This is a comparatively large group-delay slope, and it is unlikely that it can be satisfactorily reduced by equalization at the terminals. However, if conversion to a v.h.f. intermediate frequency is carried out at amplifying stations, group-delay equalization at all or some of the amplifying stations is possible. For example, if the amplifying stations are spaced at, say, 20km intervals, the slope to be equalized at each station would amount to $8{\cdot}1 \times 10^{-3}$ nsec/Mc/s.

An alternative way of dealing with dispersion is to reverse the polarity of the modulation at intervals—perhaps at every amplifying station—along the waveguide. Only a very small residual group-delay slope would then remain

* *In the form of interference noise.*

to be equalized at the terminal, since reversing the polarity of the modulation is tantamount to reversing the group-delay slope. This reversal could be accomplished by suitable frequency conversion (possibly associated with intermediate-frequency amplification) and not necessarily by translating the signal to the baseband.

It may be concluded that dispersion, although causing some difficulty in f.m. transmission, does not present any insoluble problems.

Conclusions

It may be concluded from the approximate analysis described that the transmission of f.d.m. telephony signals over long distances, using the H_{01} mode in circular waveguide, is possible by frequency modulation of a carrier. It has been shown that the problems of H_{01}-mode attenuation, parallel-flow and echo-signals, and dispersion do not present insurmountable difficulties. These conclusions are valid only if the waveguide is deliberately designed and laid in such a way that the distribution of imperfections and discontinuities is as random as possible.

It may further be concluded, subject to experimental verification, that a plain copper waveguide coated internally with a suitable lossy dielectric film may constitute a satisfactory transmission medium.

Acknowledgments

Acknowledgment is made to the Engineer-in-Chief of the Post Office and to the Controller of Her Majesty's Stationery Office for permission to publish this article.

The author wishes to thank Mr. F. J. D. Taylor and Mr. R. W. White for the many stimulating discussions that have helped in the work, and Mr. R. J. Westcott for carrying out an experimental verification of the theory of dielectric-coated waveguides.

Appendices

(1) Attenuation due to Mode Conversion

The waveguide is assumed to consist of a large number of random lengths, l_r, with an H_{01}-mode fractional power loss of w_r' at the end of each length. The lengths are all very small compared with the waveguide run, and the power loss, w_r', may be due either to point imperfections or distributed distortion; in the latter case the power loss throughout the distorted length is assumed for simplicity to take place at the end of the length. Each parasitic mode, and the waveguide imperfections causing coupling to it, are treated separately, and the total mean power loss per unit length is obtained by addition of the losses arising from all relevant modes.

With unit input power to the waveguide, the power remaining in the H_{01} mode at the end of the r^{th} section (for a given parasitic mode) is:

$$p_r = \prod_1^r (1 - w_r') \exp\left(-2\alpha \sum_1^r l_r\right)$$

where α is the H_{01}-mode attenuation coefficient. Since w_r' and l_r are random, they may be replaced by the mean values, w_a' and l_a, and the power p_r becomes:

$$p_r = (1 - w_a')^r \exp(-2r\alpha l_a)$$

If the total waveguide length is L, equal to nl_a, and $w_a' \ll 1$, a good approximation for the H_{01}-mode power, p_n, at the end of the waveguide line is:

$$p_n = \exp - (2\alpha L + w_a' L/l_a)$$
$$= \exp(-2\alpha' L)$$

where α' is the new effective attenuation coefficient. Noting that w_a'/l_a is the mean power loss, w', per unit length to the given parasitic mode, the increment in the attenuation coefficient is $\delta\alpha = \frac{1}{2}w'$.

(2) H_{01}-mode Power Loss due to Distributed Coupling

If the relative attenuation in the parasitic mode is zero, the power transferred to the parasitic mode throughout a length of constant distributed coupling is:

$$p = (2\sigma^2/\Delta\beta^2)(1 - \cos\Delta\beta z)$$

where σ is the coupling coefficient per unit length. When the relative attenuation is not zero, the full analysis using coupled-line theory leads to a somewhat unwieldy solution. A simple approach on the following lines provides an adequately accurate result.

At the end of a length corresponding to a half-cycle of power transfer, the power in the parasitic mode, attenuated by the relative attenuation coefficient, $\Delta\alpha$, is:

$$p_2 = (4\sigma^2/\Delta\beta^2)\exp(-2\pi\Delta\alpha/\Delta\beta)$$

The wave power in the parasitic mode can now be regarded as coupling in a similar manner back to the main mode throughout the second half-cycle. The wave again suffers attenuation in the parasitic mode, the power returned to the main mode being approximately:

$$p_1 = (4\sigma^2/\Delta\beta^2)\exp(-4\pi\Delta\alpha/\Delta\beta)$$

Consequently, the power lost per transfer cycle is:

$$p = (4\sigma^2/\Delta\beta^2)[1 - \exp(-4\pi\Delta\alpha/\Delta\beta)]$$

(3) Gradual Diameter-Tapers

Provided the taper is gradual, it may be simulated approximately by a series of equal-spaced, variable height steps. Then, if the step spacing is δx:

$$s'(x) = \delta s/\delta x$$

where $s(x)$ is the radius function defining the taper. Making use of the formula in Table 1 for the coupling coefficient, c, at a step, it immediately follows that:

$$\sigma(x) = 2\frac{\chi_{01}\chi_{0n}}{\chi_{01}^2 - \chi_{0n}^2}\frac{s'(x)}{s(x)}$$

where $\sigma(x)$ is the coupling coefficient per unit length. In a gradual, linear taper:

$$\frac{s'(x)}{s(x)} = \psi/s$$

where ψ is the radius taper angle; thus:

$$\sigma = 2\frac{\chi_{01}\chi_{0n}}{\chi_{01}^2 - \chi_{0n}^2}\psi/s$$

(4) Solution of Parallel-Flow Problem

It has been shown that the parallel-flow power of delay $T_z\,(=az)$ is:

$$\eta_z = w^2(L - z)\exp(-2\Delta\alpha z)\,\delta z$$

and, with f.m. noise loading, the intermodulation noise power resulting from this echo is a function of η_z and T_z. The mean intermodulation power when considering one of a large number of random-phase echoes may be obtained by taking half the sum of the noise powers given in equations (5) and (6) of reference (14). The result is:

$$W_{Dz} = (w^2u/\pi m^2)(L - u\theta)\exp - \{2\Delta\alpha u\theta + 2m^2[\theta\mathrm{Si}(\theta) + \cos\theta - 1]\}$$
$$\int_0^\infty [\exp(-\psi(\tau)) + \psi(\tau) - 1]\cos\tau\, d\tau\, \delta\theta \quad \ldots\ldots \text{(i)}$$

where $\theta = 2\pi f_n T = z/u$

$$\mathrm{Si}(\theta) = \text{sine integral}, \int_0^\theta \frac{\sin y}{y}\, dy$$

$$\psi(\tau) = 2m^2[(1 - \cos\theta)\cos\tau + \tau\,\mathrm{Si}(\tau) - \tfrac{1}{2}(\tau+\theta)\,\mathrm{Si}(\tau+\theta) + \tfrac{1}{2}(\tau-\theta)\,\mathrm{Si}(\tau-\theta)]$$

and other symbols are as already defined. The modulation is assumed to consist of a uniform band of random noise extending from zero to the frequency f_n, and W_{Ds} is the normalized intermodulation noise power at f_n.

On the assumption that the intermodulation noise power arising from echoes of different delays may be added, the full intermodulation noise is the summation of W_{Ds} for all $\delta\theta$. In the limit, this is:

$$W_D = (w^2u/\pi m^2) \int_0^{L/u} \left\{ (L-u\theta)\exp - \{2\Delta\alpha u + 2m^2[\theta\,\mathrm{Si}(\theta) + \cos\theta - 1]\} \int_0^{\infty} [\exp(-\psi(\tau)) + \psi(\tau) - 1]\cos\tau\, d\tau \right\} d\theta \quad \ldots . \text{(ii)}$$

Equation (ii), which requires evaluation by a computer, is a more accurate solution of the parallel-flow problem than that used in the article.

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A High Supersonic Speed Wind Tunnel

A new 4ft by 3ft wind tunnel has recently been brought into operation at the Royal Aircraft Establishment at Bedford and forms an extension of the range of major tunnels already in use there. This new high supersonic speed tunnel is at present operating at a fixed speed of Mach 4, but when the flexible nozzle is completed and installed it will be operable over the range Mach 2·5 to 5. The tunnel is of the continuous flow type and when completed it will be possible to alter both the tunnel pressure and Mach number during the course of a run.

The instrumentation of the model under test is fairly conventional and attitude control of the model and all data observation and recording is carried out in a central Observation Room.

The model under investigation is mounted on a sting shaft which, in turn, is mounted on a moving quadrant. The quadrant is used to alter the pitch of the model within the limits of 5° depression and 27° elevation, while the sting can rotate the model through ±180° from a mean position. These movements can be remotely controlled when the model-support section is in the line of the tunnel. When the section is in the rigging bays, it is sometimes necessary to be able to reproduce the movements of the sting which occurred when the section was in the tunnel, and portable control cabinets are provided for this purpose.

Control based on the Ward Leonard principle is provided for both pitch and roll. A single 3·8 h.p. induction motor drives two 1·1kW d.c. variable-voltage generators each of which supplies a 1 h.p. separately-excited d.c. motor. One of these motors drives the moving quadrant and the other the sting. The control arrangements for speed and position of the quadrant and the sting are identical.

The operation of the moving quadrant electrical control system is based on the balance existing between a magslip coincidence transmitter actuated by the quadrant and a magslip transmitter located in the Observation Room, and under the control of the operator. Under conditions of equilibrium equal currents pass through the opposing fields of the 1·1kW d.c. generator and consequently there is no output to the 1 h.p. quadrant driving motor. If, however, the operator alters the position of the magslip transmitter, which is calibrated in angles of depression and elevation, an error signal is introduced into the magslip system which is then fed, via a transistor amplifier, to the opposing fields of the d.c. generator. This signal causes the current in one field to increase and in the other field to decrease, so that the output of the generator is applied to the quadrant driving motor which then rotates in the required direction until coincidence of the two magslips is re-established.

Refinements incorporated in the control circuit include the use of coarse and fine magslips, the fitting of a tacho-generator geared to the quadrant drive to assist stability and permit precise speed control, a position-error indicator and a digital display and read-out system.

Measurements on the model under test are made, in general, by means of strain gauges, manometers and thermocouples.

For force recording provision is made for automatic balancing of ten Wheatstone bridge circuits, for plotting the readings against a chosen parameter, e.g. model incidence, and for digitizing and recording the results in punched-card form suitable for supplying to a digital computer. A typical channel consists of a strain gauge circuit in which the balancing is completed by the slidewire of a strip chart recorder; this recorder plots the results across a paper chart while the chart itself moves to keep pace with another variable such as model incidence. The shaft rotation of the strip chart recorder is digitized, stored and read out on demand to the gang summary punch. The punched card output is analysed by feeding into a digital computer.

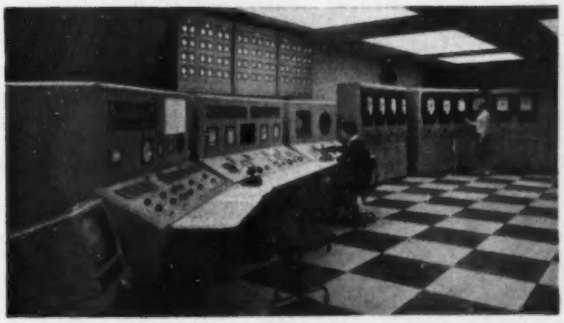
A total of 72 R.A.E. type weigh-beam manometers (Midwood manometers) is available for pressure recording. Each manometer automatically balances the pressure in the capsule by moving a jockey weight along a weigh beam and the position of the jockey weight is transmitted to a dial indicator, also to a tape indicator and via a digitizer to a gang punch.

Three strip chart recorders are included in the system and each can plot 24 pressures on the X axis while the Y axis (the paper roller) moves to correspond to a preset dimension such as the proportion of wing chord at which the particular point is located. Thus a typical plot could be a pressure distribution around a wing profile. The strip-chart plot is an analogue system taking its information from potentiometers on the weigh beam transmitter repeaters.

In addition to the measuring and recording equipment a 625 line closed circuit television system is installed for viewing the model under test. The miniature camera which is employed can be completely controlled, including pan, tilt, traverse, lens interchange and focusing, from the control desk in the Observation Room.

The design and construction of the wind tunnel were carried out by the Ministries of Works and Aviation and a number of industrial firms. The major part of the instrumentation was supplied by the General Electric Co. Ltd while the closed circuit television equipment was supplied by Pye Ltd.

The observation room



An Automatic Check-Out and Recording Network

By R. Mansey*

This article describes an existing British automatic check-out equipment, designed for a missile system, which has proved suitable for any aircraft or similar system where the parameters are predominantly electrical.

The methods of accepting the input signals are discussed, together with selection and comparison with a standard. The design of a unique self-balancing potentiometer is described, showing how the standardized input is used to operate a bi-directional staircase generator until parity is reached between the staircase output and the input.

The article concludes with a brief summary of the application of the equipment to the check-out of aircraft.

(Voir page 336 pour le résumé en français; Zusammenfassung in deutscher Sprache auf Seite 342)

THE subject of automatic checking, particularly of modern aircraft, has become increasingly important as more and more skilled personnel are required to ensure that the various systems function satisfactorily prior to take-off. It is fast becoming evident that saturation will shortly be reached unless either more simple tests are introduced or a method found to use relatively unskilled personnel for checking without increasing the time taken. In fact, the time must be reduced considerably.

The existing check-out procedure of modern military aircraft is a complicated exercise involving a vast array of test equipment, innumerable assorted trolleys, and a veritable swarm of inspectors. Fault finding is difficult and servicing lengthy. The Americans have long realized this and, with typical transatlantic enthusiam, have invested large sums of money in automatic check-out equipment. They have also designed aircraft/missile systems particularly for the use of the equipment, which has been of considerable assistance in evaluating performances.

In this country, considerable thought has been given to the basic requirements. It is realized that automatic check-out is no panacea, in fact, it presents many problems in its own right and a real danger exists that the inevitable teething troubles would prejudice its introduction to an excessive degree. A number of firms have been engaged on the study of check-out equipment and the following description is the result of research carried out by De Havilland Aircraft Co. Ltd.

Initial Conception

During the design of the 'Blue Streak' ballistic missile, it was apparent that the many systems would require a rapid check during 'count down' prior to firing. Manual test equipment was obviously unsatisfactory and a study was made of the precise requirements in order to establish a design specification.

A prime consideration was that the equipment should meet the requirements of various well-known inter-service specifications covering mechanical and electrical standards of workmanship and environmental, operational and storage conditions.

The input power should be taken from the normal mains supply.

An analysis of the missile systems showed that, at that stage, all parameters requiring to be checked could be translated in terms of one of three electrical quantities, d.c. voltage, sinusoidal a.c. voltage or varying frequency.

Although the prime requirement was for a continuous sequence of tests, culminating in a complete clearance of all parameters, it would be essential to be able to select one particular channel for re-setting or fault finding purposes and in many instances to select a small routine of tests. In fact, it was finally decided that four main routines should be made available, each housing a maximum of 88 channels and each main routine should contain up to 8 sub-routines. Selection of all the different types of requirement was necessary at will, together with termination at any time with the exception of main routines during the 'launch' sequence.

In order to keep the input measuring lines as short as possible, the equipment must necessarily be sited near the missile, much nearer than personnel could remain during 'count-down'. A form of remote control was, therefore, essential, such remote control having precedence over all local actions.

The method of read-out required considerable thought. With so many differing parameters, each with its own limits, a form of standardization was essential. One man ultimately had the responsibility of firing, and he had to be given information in a manner easy to assess. A simple pass/fail system was unsatisfactory, as the degree of both states was often vital. An unnecessary hold-up would have been very costly. It was eventually decided that the simplest form of read-out for easy assessment was to take a nominal value for every parameter, which was its mid position between extremes of tolerance, and call this value 0·0. The bottom limit of its tolerance then became $-1{\cdot}0$ and the upper limit $+1{\cdot}0$. Thus, any result between $-1{\cdot}0$ and $+1{\cdot}0$ was satisfactory. It was considered that the degree of failure on all channels could be assessed within a total of five times the tolerance value, as, beyond this state, a major failure had occurred. Thus the limit of read-out would be $-5{\cdot}0$ to $+5{\cdot}0$ which, in terms of single digits, represented 100 steps. The examiner would therefore only see a succession of figures within this bracket and could assess any measurement without knowing what the particular channel was actually measuring. In this respect, he would be the equivalent of a semi-skilled operator. Additional to the read-out, a permanent record was necessary and, at that time, the simplest solution was the use of an

* *De Havilland Aircraft Co. Ltd.*

electric typewriter, modified so that signals from the equipment could operate the number keys, + or − sign and the red and black ribbon change.

The input parameters were studied in more detail and were found to fall generally into three categories: the standard inputs, voltages and frequency; super inputs, specially tailored for complex measurements; and continuously monitored inputs for vital services. Finally, an action or executive facility was necessary on many channels and it was therefore specified that every channel be provided with an executive function so that some action could be taken before, during or after measurement. Suitable delays were to be provided as necessary.

This brief specification shows that the initial conception is in many ways applicable to any structure or equipment containing a variety of systems where electrical signals are available for monitoring purposes. Furthermore, the type of read-out enables a considerable reduction to be made in the number of skilled men necessary for check-out.

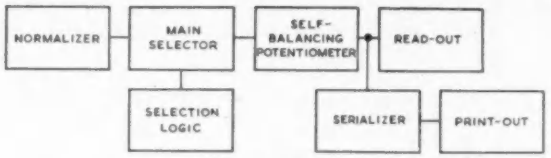


Fig. 1. The provisional system

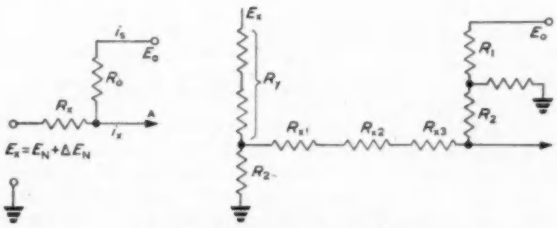


Fig. 2. (left) Simple d.c. normalizer
Fig. 3. (right) Final d.c. normalizer circuit

Basic Design Accuracies

Any test set for service equipment should measure to an accuracy of one order of magnitude better than the specification for the system under test. For general d.c. voltages, it has been established that an accuracy of one part in 10^3 is possible with half an order lower accuracy for other parameters, thus allowing a system designer to specify tolerances to 1 per cent on the equipment. In exceptional cases, the flexibility of ACORN permits special measuring circuits to be introduced through the executive facility so that more accurate measurements can be made. Frequencies can be checked more accurately than d.c. voltages, to one part in 10^4 allowing spot frequency tolerances to be specified to one part in 10^3.

Description

The specification determines the provisional system shown in Fig. 1.

Taking the figure in sequence, the first item is the normalizer. This is simply a printed circuit card 8in × 6in containing the circuit and components necessary to reduce the input signal to a standard form.

The input current is backed off against a known current source derived in discrete steps, and when the two are equal, the step generator stops. The measuring circuits therefore deal only with deviations of input about the nominal, and it is evident that if the input is in the form of a d.c. voltage, an error recorded by the measuring set-up can be arranged to indicate any percentage variation of that voltage. The basic circuit of a simple d.c. normalizer is shown in Fig. 2 where:

E_o/E_N = backing off current

E_N = nominal input voltage

$E_o/R_o = E_N/R_x$

$i_x = \Delta E_N/R_x$

It will be appreciated that point A is sensibly at earth when $i_x = i_o$.

Now $R_x = \Delta E_n/i_x$ and $E_o/R_o = E_n\, i_x/\Delta E_n$

$\therefore\ \Delta E_n/E_n = (i_x R_o/E_o) = (i_x R_x/E_n)$.

Hence any fixed percentage variation in E_n (given by $\Delta E_n/E_n$) can provide a fixed read-out indication by variation of R_o.

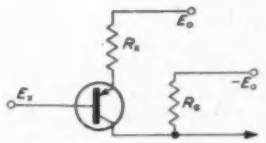


Fig. 4. High impedance normalizer circuit

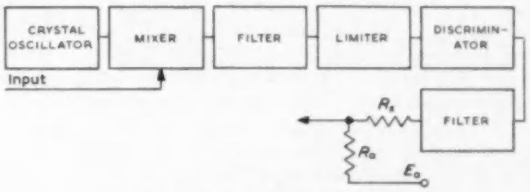


Fig. 5. Frequency measurement

The number of tolerances provided by different values of R_o is kept within practical considerations by limiting the number to 12, between 1 per cent and 20 per cent. However, unless the input parameters are identical in respect to both the nominal value and their tolerance, the value of R_x required will differ in each case to an unpractical total, and therefore each value of R_x is made up of three series resistors such that a minimum stock is necessary to make up any desired value.

In order that faulty selection can be isolated from normal input tolerances, a modification to the basic circuit is necessary, such that, when the input parameter is at its nominal value, a fixed current flows in the measuring circuit, which is subsequently backed off by a fixed current derived at the step generator. If now, the selector is at fault and the normalizer to measuring circuit not continuous, the output indication will be the equivalent of the backing off current only. The final d.c. normalizer circuit is therefore as Fig. 3.

The circuit for a.c. voltages consists of an input transformer, phase rectifier, filter and rectifier drift compensation, in addition to the basic d.c. voltage components.

A high impedance normalizer is also available for accurate measurements requiring less than the normal 100μA drain from the input source (see Fig. 4).

The transistor is a silicon unit maintained at constant temperature.

For tight tolerance frequency measurement, the circuit shown in Fig. 5 is used.

For more open tolerances, the input is fed directly to the limiter.

One further type of normalizer to be considered is that of a standard for self-checking. This comprises a card easily converted by the addition of links to check a range of different types of input. In general, all that is necessary to check ACORN is a simple d.c. card set to +1·0, 0·0 or −1·0.

The selector mechanism follows conventional telephone practice, using a high speed Siemen's motorized uniselector and digit switches. Digit switches are used for selection purposes and the most convenient method of calling up the required channel is to use a standard telephone dial. By using digit switches in pairs, it is

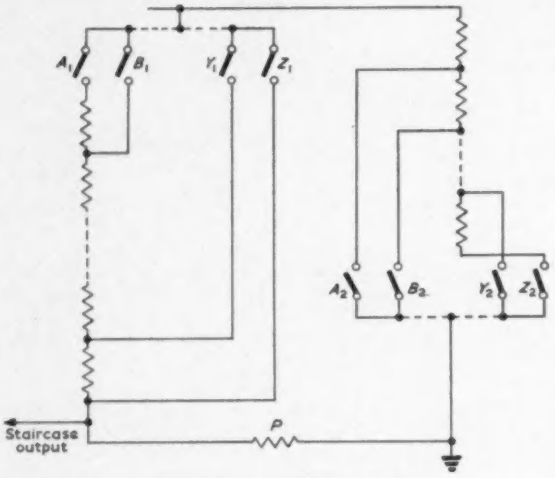


Fig. 6. Simple staircase generator

possible to call up manual, i.e. single channel tests, and routines. The channels in the routine are determined by the routine patch panels, each of which is capable of routining 88 chosen channels and of being programmed for eight sub-routines comprising an unbroken block of the main routine.

The signal from the main selector is then fed to a self-balancing potentiometer of de Havilland design. The basis for this device is a Hausrath circuit[1] as shown in Fig. 6.

Switches A_1 A_2 etc. are made together but only one pair at any time. The associated resistors are such that whichever pair of contacts is closed, the current drawn from the supply is constant. By choosing suitable resistors, a uniform step increase in current through resistor P is possible as each pair of switches is made.

It is obviously more suitable to use transistor switching and for this reason the circuit requires modification as Fig. 7.

Here, all switches A_2 to Z_2 are normally made and A_1 to Z_1, normally open and no current passes through P. When A_1 closes, A_2 opens and as $R_{A1} + P = R_{A2}$, the current drain on the supply is unchanged but a voltage appears across P equal to P_x supply voltage. A suitable choice of $P + R_{A1}$ resistor values again produces step generations from successive switch operations. The switches in this circuit are two sides of a transistor bistable circuit of the Eccles-Jordan type.

A further departure from the Hausrath circuit is the use of twenty bistable switches, two of which may be operated at one time. This is necessary since the generator is required to work to a radix of 10 and nine bistable switches feed increments of current corresponding to non-zero units of the digital scale and nine corresponding to multiples of ten. A small error is introduced by this modification which is minimized by keeping the output voltage small compared with the supply voltage.

Generator inaccuracy due to cut-off current is to some extent alleviated by using a circuit in which the 'tens' switches and 'units' switches cause currents to flow in P in opposite directions, thus giving some cancellation of open-circuit leakage current. If a transistor is turned off in one group only, the effect of the unbalanced current (I_{co}) is reduced by choosing the value of P such that PT_{co} is very small compared with the voltage step for one unit.

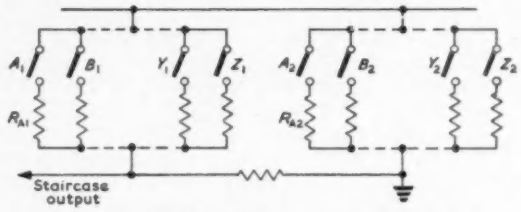


Fig. 7. Staircase generator with transistor switching

A second source of inaccuracy due to potential drop across a 'turned on' transistor, produces an effective reduction in the potentiometer supply voltage. In contrast to the unbalanced current error, which is of constant magnitude, the p.d. error increases as the digit becomes larger. It is thus most serious for the 'tens' switches. A careful assessment of the values for P and the supply voltage is necessary to establish the best compromise solution.

Each bistable circuit is turned on and off by a shifting register, capable of translation in both directions, i.e. bi-directional. The register driving the 'units' switches is joined end to end, forming a ring counter, and driven by a clock oscillator so that translations of state occur at regular time intervals. The transitions 0-9 and 9-0 generate a carry pulse which produces unit translation in the 'tens' register. Logic is applied to the register to prevent 9-0 transition in the 'units' ring when the 'tens' ring is at 90. Similarly, the 'units' transition 0-9 is inhibited when the 'tens' ring is at 0.0. These two conditions represent the upper and lower limit of output from the staircase generator.

Two types of shifting register have been developed, both proving satisfactory. In the first, the transistor bistable circuits themselves are used as the elements of the shift register, coupled by diodes. In the second, square hysteresis loop ferrites in the form of toroids were coupled by transistors.

The diode register arrangement is as follows and shows the arrangement of two elements of a basic N stage shifting register employing diode capacitor short stores and bistable multivibrator memories. For simplicity, the circuit is shown in unidirectional form in Fig. 8.

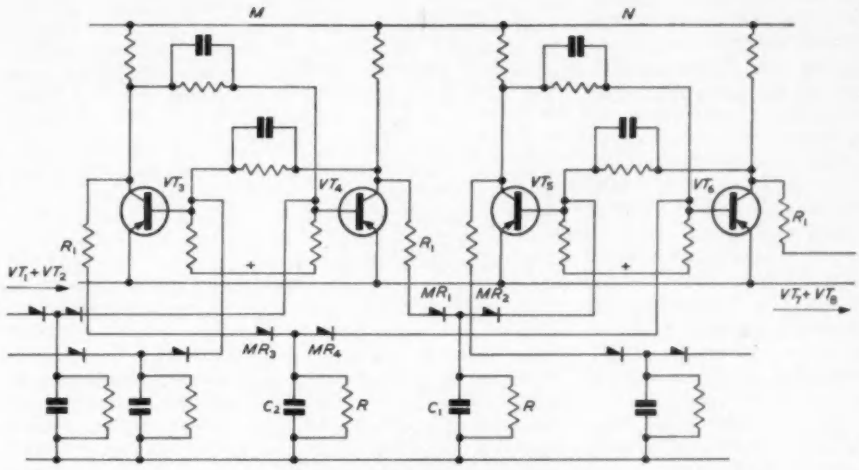


Fig. 8. Unidirectional diode shift register

This circuit can exist in one of four states

(1) Element M on — Element N on
(2) „ M on — „ N off
(3) „ M off — „ N on
(4) „ M off — „ N off

Assuming the circuit exists with M on, the shift line is normally held at potential $-V$.

Capacitor C_1 is charged to $+V$ with respect to the shift line and capacitor C_2 left uncharged, provided R is less than the reverse resistance of diode MR_2. When a positive shifting pulse is applied, the charge on C_1 is transferred through MR_2 to VT_5 base, turning that transistor 'off', and element N 'on' in consequence. Additionally, as C_2 is uncharged, MR_3 and MR_4 remain closed throughout the switching sequence.

Conversely, with M off, capacitor C_2 transfers its charge through D_4 to VT_6 base, which switches element N off.

The operation of each element of the register is identical to the above, thus when the last (N^{th}) stage is coupled to the first stage, information initially set in the register is transferred round the closed loop at a rate of one element/shift pulse. After application of the pulse, the shift line returns to $-V$ and the appropriate capacitors charge through resistors, the values of which allow the capacitor to charge within the pulse period. However, as the trailing edge of the shift pulse introduces a negative spike on the collector of the 'on' transistor, the value of R, must be sufficient to prevent spurious triggering of the bistable circuits.

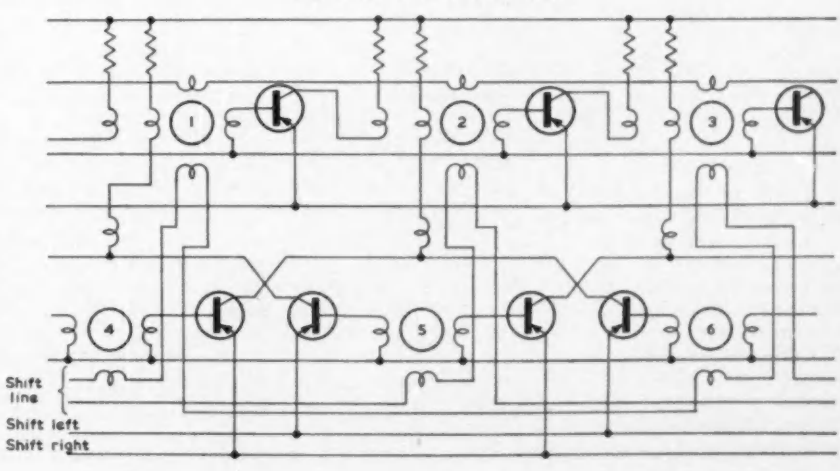
In practice, as previously stated, the register is bidirectional, operation of each element being identical to the basic system described, but with two short stores for each bistable acting from shift right and shift left lines respectively, one line being dormant and the other active at any instant.

The alternative magnetic register contains a ring of ten magnetic cores arranged in a circuit coupled by transistors in such a way that all the cores but one are magnetized in a certain direction, the odd core being magnetized in the reverse direction. The 'odd' state of magnetization can be shifted along the ring in either direction and the process of shifting serves to set up the bistable multivibrator circuits associated with the staircase 'units' steps. An identical ring of cores sets up the bistables associated with the 'tens' steps. The latter ring is driven from the unit or zero core of the units ring depending on direction and therefore transfers at $1/10^{th}$ the rate of the units ring. (Fig. 9.)

A further shift register is provided for fast parallel read-out, comprising twenty-six cores. It is a single line shift register which is connected to the 'units' and 'tens' registers and is arranged to operate in two separate conditions (a) as a normal single line shift register with four cores holding '1' states and twenty-two cores holding '0' states and (b) as a set of cores tied electrically in parallel with the 'units' and 'tens' registers.

With reference to condition (a), four '1' states can be set into it and if the shift pulses are applied then these digits will circulate around the ring at the original set time spacing. With a small shift pulse width compared with the time between pulses, a period exists with the register at rest, when the '1' digits could be changed to form a different pulse pattern. By arranging the 'units' and 'tens' registers to operate when the fast register is at rest, the fast register, which has two blocks of ten of its

Fig. 9. Ferrite core shift register



cores tied electrically in parallel with the other registers, follows movement of the '1' digits in those registers, providing its '1' digits coincide correctly.

The null detector is designed to cover the condition that the slow read-out should only be performed when a balance has been obtained. It is therefore possible to use the technique of arranging 'dead space' extending to $\pm\frac{1}{2}$ step about balance, instead of causing the potentiometer to hunt. The null detector also must have a low input impedance to avoid disturbing the current relations in the circuit. In order to obtain this type of detector, a method of modulation, a.c. amplification and phase sensitive demodulation is used.

A fast response amplifier having a relatively high drift combines with a slow acting drift correction amplifier. Using silicon transistors, a much reduced drift is obtained by working the transistor at a temperature of about 80°C.

Taking the basic circuit in Fig. 10, it will be seen that with S_1 open, C_1 will charge to the d.c. level applied through R and discharge through R on closing S_1 in the opposite direction. The amplitude of the waveform depends entirely on the amplitude of the d.c. input.

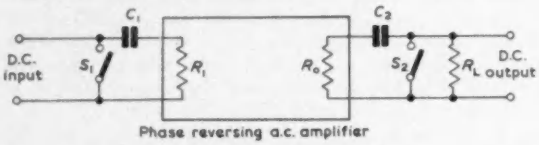


Fig. 10. Diagram of d.c. amplifier

The a.c. waveform completes a phase reversal from input to output of the amplifier. With S_2 open-circuit, the voltage across R_o charges C_2 through R_L. When R_o voltage reverses on closure of S_1, S_2 closes and the voltage across C_2 is equal and opposite to R_o voltage. Thus C_2 will not discharge and the result is an amplified d.c. output of reversed polarity from a d.c. input.

The chopping waveform generator used in the above is a normal transistor multivibrator with output stages of emitter-followers at a frequency of 10kc/s for easy filtering. As mentioned, silicon transistors controlled at 80°C ± 2°C provided conditions of minimum drift. The choice of base current for the transistor at this temperature is governed by the fact that the bottoming potential becomes lower with increasing base current. A typical spread of collector/emitter voltage is from 1 to 3mV with a current spread of 50 to 100mA through a 25kΩ resistor. The collector to emitter impedance is in the range 200 to 500Ω and since the sensitivity of the detector must be in the order of 1·25mV, it is possible for transistor spreads to vary the output voltage over the full range. By raising the collector potential during the clamped period, it is possible to nullify the spreads. The very sharp changes in potential at the base of the input transistor

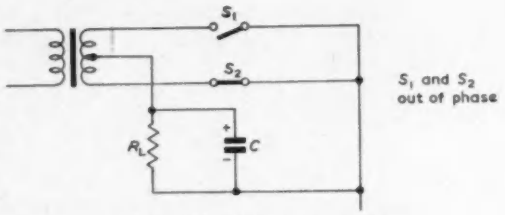


Fig. 11. The phase sensitive rectifier

are highly differentiated at the emitter causing a spiky a.c. signal at zero d.c. input and thus a zero error. Compensation is made for this by an appropriate d.c. bias in the output stage as the error induced is always in the same direction.

The amplifier comprises four stages using r.f. transistors giving a gain of 20V/μA with −20V h.t. An additional output stage with a gain of 3 gives 60V/μA without saturation. Gain control is provided by the addition of overall negative feedback and sensitivity can be controlled from ± 0·8mV to ± 2·0mV input for ± 2·0V output. The phase sensitive rectifier circuit is given in Fig. 11.

The operation is conventional, giving full wave rectification and a ripple frequency of 20kc/s at C. This is filtered by an LC circuit. The switching limitations of the transistors are overcome by keeping the switching waveform peak voltage as high as possible.

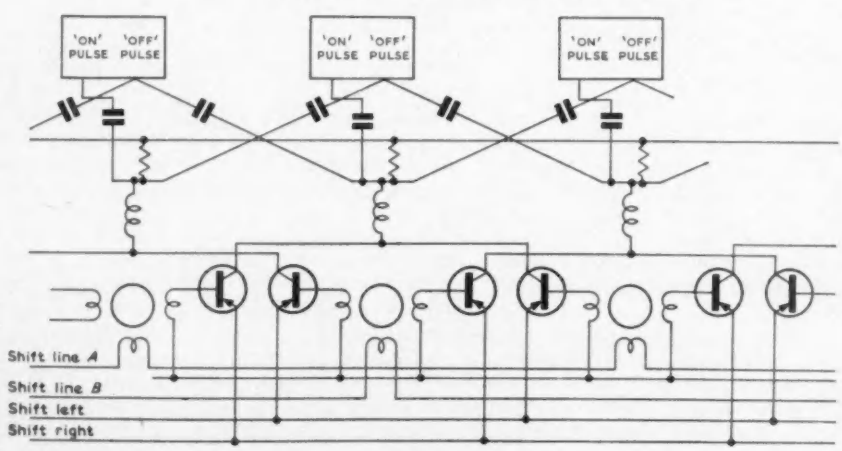
The purpose of the null detector is two-fold (a) to indicate dead space and (b) to indicate the polarity of error, and hence the direction of staircase shift. The output of the null detector is therefore fed to logic circuits whose output states are shift right, no shift or shift left. The block diagram in Fig. 12 provides an impression of the logic.

Three inhibit conditions apply as follows:

(a) The null detector dead space, which occupies $\pm\ \frac{1}{2}ZI$ where I is one staircase step and Z is the null detector transfer impedance. The shift left and shift right amplitude discriminators are arranged to trigger at $+\frac{1}{2}ZI$ and $-\frac{1}{2}ZI$.

(b) The end stop condition when the staircase exists on steps 99 or 00 and the shift left and shift right gates respectively are operating. The requirements are conditioned by an AND group consisting of 0 on the 'units'

Fig. 12. Null detector logic using magnetic cores



decade, 00 on the 'tens' decade and the shift right gate closed in OR combination, with an AND group consisting of 9 on the 'units' decade, 90 on the 'tens' decade and the shift left gate closed. This logic prevents continuous hunting of the staircase waveform generator when the input parameter is outside the total range.

(c) The shifting operation is inhibited before and during any step change of the input. This ensures that if the input is a step function or any other function which coincides with some part of the generated shifting pulse, it will not introduce a spurious bit due to insufficient turn off pulse or vice versa. The inhibit is achieved by a delay circuit introduced into the logic input, total inhibition occurring over the period of the delay plus one shifting operation. Further logic is necessary to determine the time at which the 'tens' register of the previously described bi-directional shift register is energized. If, say, the register is shifting right, i.e. 99, 00 then a 'tens' decade shifting pulse must be derived from the transition 9 0 in the 'units' register. The converse is also true. It is, therefore, possible to obtain 'tens' decade transfer pulses from both the 9 0 and 0 9 'units' transition and the unwanted pulse is inhibited in conjunction with the direction of shift in the input stage of the logic.

It is now possible to discuss the read-out of the self-balancing potentiometer previously described. Three types were originally required and are available, although the fast read-out is now considered unnecessary.

The first requirements are for value sampling after finding the first balance, which is presented in parallel to a series of visual digital displays and in serial form in the first instance to an electric solenoid operated typewriter.

The fast read-out is value sampling every millisecond whether or not balance has been found, and after suitable coding, recorded on magnetic tape.

In the slow read-out circuits, the state of the bistable circuits in the potentiometer are used to set up an ensemble of relay contacts capable of passing the powers required to drive the visual displays and solenoids. As the current drain from the potentiometer can only be small to maintain its accuracy, it is necessary to provide a separate controlled source. This consists of a bank of cold-cathode tubes (CV 2434) fired by a potential of 50V. Switching transistors with 60V collector ratings drive the gas-filled triodes.

The valves drive a small cross-bar type of switch[3] known as a bi-quinary relay manufactured by T.M.C. The switch has six actuating coils, five known as finger magnets and the sixth as the main operating magnet. Energization of one of the finger magnets effects a mechanical linkage such that when the main magnet is energized, a row of eight 'make' contact pairs are closed, these contacts being associated with the particular finger magnet. More than one finger magnet can be energized before the main magnet but once the main magnet is operated, no further finger magnet movement is possible and their energizing current can safely be removed.

In order to use the five finger mechanisms, the decimal output of the potentiometer is converted to the bi-quinary scale, i.e. the decimal number is represented by two digits, one to base five and one binary. Successive odd and even numbers are paired, each pair being identified by a quinary digit and the 'odd' or 'even' indication by a single binary digit. Conversion is carried out by simple diode OR gates.

Reconversion to decimal form is achieved by storing the binary digit in a relay arranged to 'hold up' when energized and the eight contact pairs of each finger magnet are divided into four odd and four even numbers. The groups of four are wired in series with a 'make' contact for odd and a 'break' contact for even on a binary digit storage relay, and to the 50V d.c. supply used to drive the electromechanical components. Thus, for any decimal digit, a unique group of four contact pairs on the cross-bar bridge will show 50V on the side remote from the binary relay. This voltage is fed to the display tubes.

A conventional electromagnetic relay shifting register is used as a serializer to convert the parallel read-out information to serial form for operating the electric typewriter, the keys of which are controlled by solenoids.

The fast read-out system is used only with the magnetic register previously described and exploits particular characteristics of the ferrite cores. The signal is in the form of a pulse width system in which a width modulated pulse comes first for the most significant digit, followed by a constant width pulse, the position of which gives the value of the units digit. The waveform is generated by a ferrite core shifting register, the cores of which are coupled to, and set by, the cores of the magnetic register.

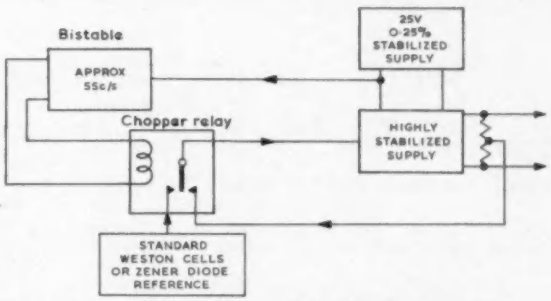


Fig. 13. Diagram of stabilized power supply

Various stabilized power supplies are required to complete the summary of ACORN. These are all made up into printed circuit cards 8in × 6in so that they can be contained in the same type of packing as the normalizers.

A 50V 5A supply is necessary for the electromagnetic components and is a straightforward series stabilizing circuit with germanium rectifiers and a choke input filter.

A more complex 20·5V reference supply is necessary for the self-balancing potentiometer. In the first instance, ten saturated 'Weston' cells in an oil bath controlled to 20° ± 0·1°C provide the voltage reference for the unit, but in later models, an oven controlled Zener diode reference is used. The general arrangement is shown in Fig. 13.

In order to provide a circuit capable of dealing with both mains and load variations, the power supply is initially fed from an existing source already stabilized to ¼ per cent.

An Ericsson Mk. III polarized chopper relay is used to switch between the reference voltage cells and the centre-tapped wirewound precision resistor connected across the output terminals of the unit. The relay is driven from a bistable circuit to eliminate mains pick-up. Any potential difference between the reference voltage and the output voltage is amplified and fed back into the loop, so that the output is restored to the correct level.

The bistable circuit is a conventional transistor sym-

metrical circuit supplied from the 25V stabilized supply, operating at approximately 55c/s.

The highly stabilized supply comprises an a.c. coupled amplifier with a gain of approximately 400, capable of accepting the square wave output produced by the chopper relay. The first stage is a high input impedance emitter-follower, a.c. coupled to minimize the current drain from the reference source, and the second and third stages are emitter-coupled pairs, a.c. coupled, and fed to another emitter-follower to provide a low output impedance.

The supply for the amplifier is taken from the 25V source and reduced to 5·6V by a Zener diode and resistor. This provides a reasonably constant supply voltage with temperature variations.

Fig. 14. The highly stabilized supply

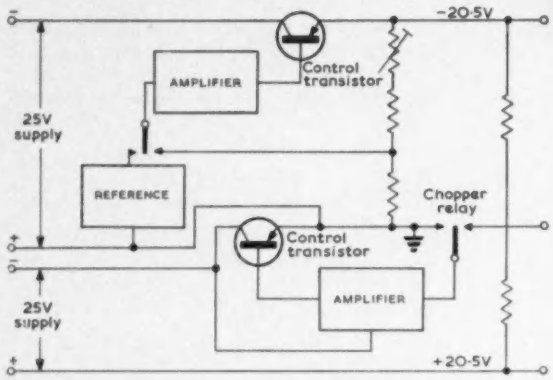


Fig. 15. Diagram of measuring circuit operation

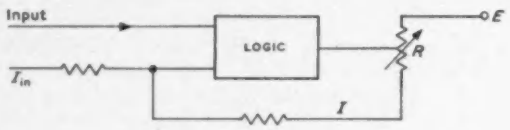
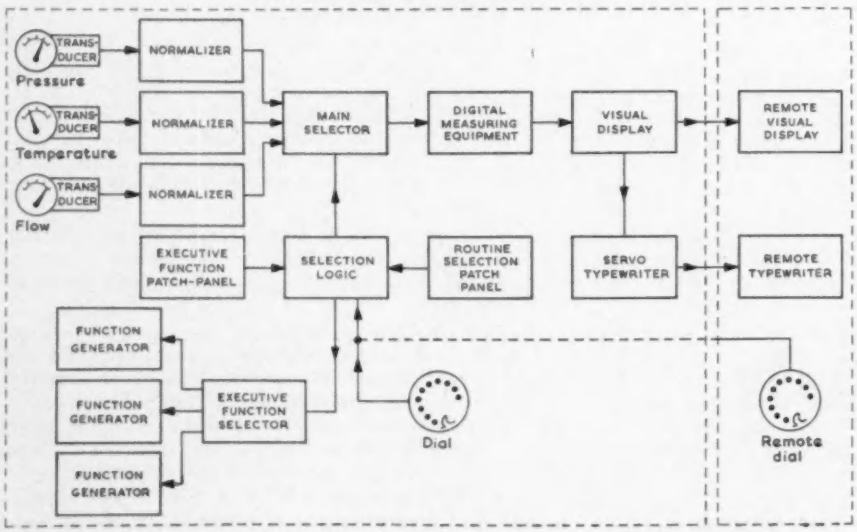


Fig. 16. Arrangement of complete circuit



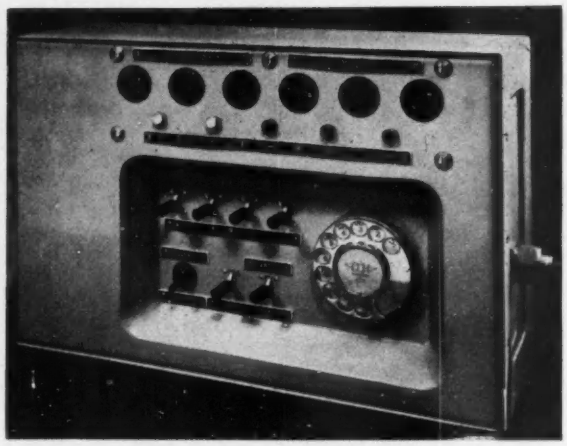


Fig. 17. The remote control unit

The square wave output from the amplifier is then fed to a transformer and then to a separate pair of contacts in the chopper relay. These contacts only allow the negative going square waves to pass through to the regulator in order to turn the first transistor on. Transformer coupling and an inductive capacitive filter reduces switching transients to a low level and keeps the d.c. output of the regulator below 1mV.

The general circuit is as Fig. 14; a centre-tapped precision wirewound resistor being connected across the two d.c. outputs.

This highly stabilized supply is stable to one part in 10^4 from no load to full load over a temperature range of 25 to 45°C and a mains variation of ± 12·5 per cent.

The 25V supply is a conventional series stabilizing circuit with a capacitor, choke and capacitor input filter supplied from normal mains via a transformer.

A highly stable voltage is also necessary for the 'units' staircase in the self-balancing potentiometer at a level of 5·1V. It is stable to one part in 10^3 under the same conditions as the 20·5V supply. To obtain the required voltage a stabilized output of 15·4V is provided which backs off the highly stable 20·5V supply.

A further power pack of 150V feeds the read-out tubes, using Zener diodes as a reference source in a conventional manner.

Briefly, then, the input parameter is normalized for value and tolerance and fed to the motorized uniselector where either manual or routine selection occurs. It is then connected to the self-balancing potentiometer. When the normalized signal is on nominal tolerance, the staircase generator produces a read-out of + 0·0. The null detector output controls the running of

the registers which set up the staircase voltage, i.e. gives either positive, zero or negative voltage as previously explained, which tells the staircase to run up, stop or run down. The loop is completed by a voltage fed back to the null detector input.

The diagram in Fig. 15 illustrates the principle.

The signal is fed through the input which tells the logic network to increase or decrease resistor R. This in turn alters current I which is fed back to cancel input current I_{in}. At that point the variable resistor stops.

The value obtained from the stationary potentiometer is then fed to the read-out system as described. As the read-out and selection control is in digit form, remote control is obtained by simply paralleling the telephone dial and output signals and can thus be used at any distance from ACORN without detriment.

The various sections of ACORN previously discussed can now be combined to give the complete equipment as shown in the block diagram of Fig. 16. It is housed in 6ft racks, the number of racks being dependent on the quantity of input parameters, i.e. normalizers, required to be measured.

This form of construction is obviously not suitable for mobile use but ACORN is readily adapted into units which can be installed on a trailer or in a prime mover. Remote control is effected by the box illustrated in Fig. 17. An impression of its size can be assessed by comparison with the standard telephone dial on the front panel.

It is not, at this time, permissible to discuss in detail the modifications now being carried out to ACORN in order that the many aircraft requirements can be met, but it is hoped these can be covered by a further article in the future. However, ACORN is an existing piece of check-out equipment which has three years development backing. Many successful demonstrations have been made of its capabilities, including recent displays where a standard aircraft 'black box' containing 47 checking items was tested.

Acknowledgments

The author wishes to acknowledge the permission given by de Havilland Aircraft Co. Ltd to publish this article.

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Electronic Summation Metering Equipment

Ferranti electronic summation metering equipment for use in power stations, sub-stations and other bulk supply points, was exhibited for the first time at this year's Electrical Engineers Exhibition.

The main feature of this equipment is the replacement of electro-mechanical summation by electronic methods. The conventional mechanical contactors fitted to watthour meters are also replaced by photo-electric devices. The check and total registers are driven by an electro-magnetic stepping motor, hence the need for mechanical links such as contactors, ratchets etc. has been obviated and mechanical maintenance, therefore, reduced to the barest minimum.

Although this new equipment may eventually supersede electro-mechanical equipment, it should be noted that it is completely compatible with it. In effect, the electronic equipment can drive existing electro-mechanical equipment and vice versa.

The summator, which is contained in a fabricated steel case measuring approximately 23in by 12in by 11in, can accommodate up to 18 display registers, i.e. 16 channels and 2 totalizers or variations on lower numbers of channels.

In designing the summator it was felt that 16 channels would be adequate for most summation metering schemes. A Maximum Demand Indicator of the single revolution type can be supplied either in the summator case, where the numbers of channels permit, or in a separate case of smaller dimensions.

As the entire summator is transistorized—all the circuit functions being provided by printed cards—the cubicle space has been reduced to something less than a quarter of that occupied by conventional electro-mechanical equipment. The rack for the printed circuit cards, most of which comprises bistable flip-flops, binary dividers and NOR gates as basic logical units, is located at the rear of the case. The register dials are mounted on hinged plates at the front, allowing easy access to the printed cards, which are colour coded to assist insertion. All components used on the printed cards are type approved to recognized service specifications.

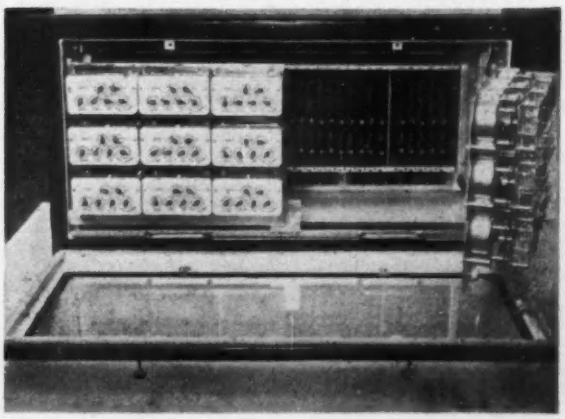
Briefly, the summator stores incoming pulses coincident or otherwise from a number of channels on display registers and totals all the pulses on a totalizing binary register. Incoming pulses, which are stored in transistor flip-flops as binary digits, are passed on sequentially to a second set of flip-flops actuating an impulse driven stepping motor, which advances one step on each reversal of current drive. These reversing impulses produce a forward step-by-step rotation of the rotor and through gearing indicates the kWh registration on the dials.

The output from the final flip-flops are differentiated and fed into a common highway in sequence to a totalizing register.

In instances where it is necessary to indicate net power, this facility can be provided by means of a reversible binary counter and logical gating. The former is a device that can increase or decrease its content by one depending upon which of its inputs is pulsed. In effect, the two highways, generated power and auxiliary power would be feeding each of the two inputs. In general the highway having the greater pulse rate would be finally feeding a net register, but only after the negative or auxiliary pulses in the counter store are cancelled.

The equipment is extremely flexible and modifications or additions to existing schemes can be effected very simply without withdrawing the equipment from site. Another facility of the summator is that sub-total registers can be provided together with printometer outputs.

The electronic summation metering equipment



A Torquemeter for Milling Investigations

By J. L. Gwyther*, B.Sc. (Eng.), M.I.Mech.E.

A torquemeter for measuring the cutting torque on a milling machine is described. A differential transformer type of transducer is employed and an output signal suitable for operating a pen recorder or for display on an oscilloscope is provided.

(Voir page 336 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 342)

POWER absorbed in cutting metals is one of the first studies of students of industrial engineering. The exact mechanics of chip removal, and the components of cutting force, are details which are considered at an advanced stage in courses, and which need instrumentation capable of isolating the separate details and measuring them. Cutting power, however, is the subject of early investigation.

A torquemeter able to measure cutting torque alone, in an exact way which indicates all fluctuations, is a valuable aid to the study of machine and cutter design. If the signals can be recorded or photographed, the exact variation of torque in intermittent cutting can be determined. In the milling process this gives information about such elements as the tooth form, spacing, helix, and depth of cut, of multiple tooth cutters.

Philosophy of Design

The torquemeter application point needs to be as close to the cutting zone as possible, so that losses due to machine efficiency are eliminated. These losses cannot be taken into account satisfactorily if variable cutting conditions are to be studied, for the machine efficiency will vary with the conditions being studied. The transducer must, therefore, be applied to the cutter arbor.

Of the six possible degrees of freedom in space, measurement will take place in only one plane. Translation of the cutter axis horizontally and vertically can be taken care of by the arbor supports: so can its rotational position. The transducer is only required to signal effects due to pure torsion of the shaft, so far as these can be distinguished.

The sensitivity of the instrument must be sufficient to detect variations of torque over the period of cut of each tooth, including variations due to cutter and arbor oscillation; and speed of response of the transmitting and indicating gear must be adequate to show these effects.

The Transducer

Mechanical and pneumatic systems for transmitting signals are at a disadvantage when it is necessary to measure rapid fluctuations. In mechanical systems the difficulties are associated with inertia of moving parts, and in the recording of the signal in pneumatic systems, the elasticity of the medium and inertia of the indicators cause problems. In the torquemeter under consideration an electrical system offers considerable advantages owing to its speed of signal propagation, and relative absence of lag effects and mass inertia obstacles in transmission and recording.

* *Letchworth College of Technology.*

Three main electrical transducers for signalling variations in length are strain gauges, differential transformers, and differential capacitors. The strain gauge is the most common of the three. Sensitivity is increased by using more gauges, and the disposition of these in positions of diametral opposition on the bar neutralizes the effect of any lateral deflexion of the arbor due to radial components of cutting force.

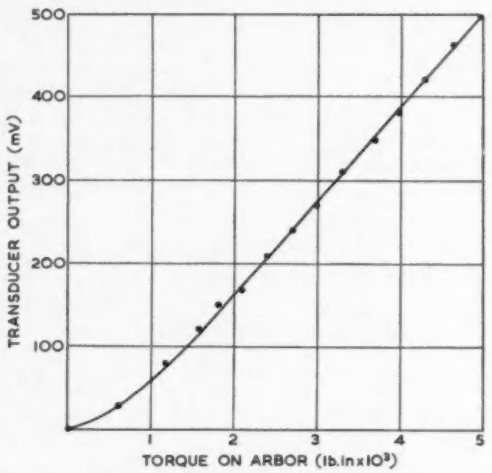


Fig. 1. Transducer output under load

The differential capacitor type transducer is sensitive but needs screening. The differential transformer device (which in fact in this application operates as a differential impedance) must be carefully made, the coils needing to be in balance.

Some experience of the differential transformer had already been gained in the making of a servo controlled fatigue machine, so it was chosen as the first transducer to be tried for the torquemeter. Results of tests (given below) and performance of the instrument under load show its ample sensitivity, even though the reference planes between which increment of twist of the 2⅛in diameter arbor is measured, are only 1⅛in apart.

The Principle of the Transducer (Fig. 2)

The centre limb of an E shaped core was wound as the primary, and the two outside limbs as secondary windings. These secondaries were wound so that the currents induced in them were in antiphase, and the resistance and inductance of each secondary were equal to those of the other. Two ends were brought out and

connected through resistors to form a bridge, the other two arms of the bridge being formed by the coils. No current flows at the junction of the resistors while the flux path is symmetrical, but if the pole piece, which completes the flux path by lying contiguous to the free ends of the E shaped core, is moved, then the two halves are thrown out of balance and a current flows at the junction of the resistors.

On the instrument as designed, the transducer output is fed from the junction of the resistors, the junction of the coils being earthed. The output goes through slip-rings on the arbor to brushes connected to the grid of a triode valve at A in the circuit diagram.

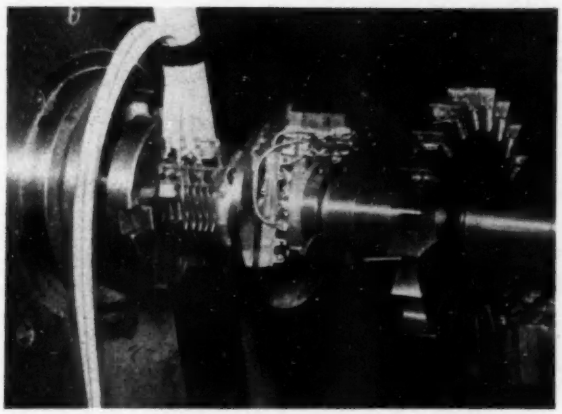
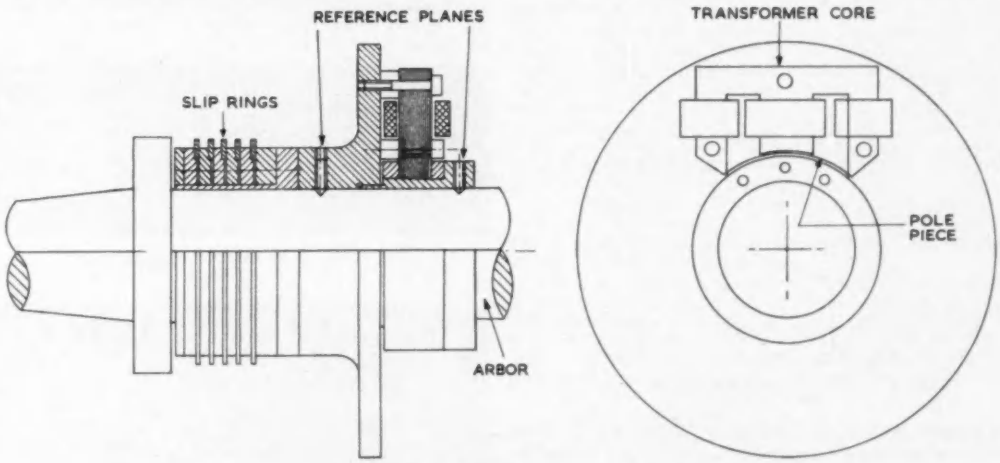


Fig. 2. (a) Torque dynamometer mounted on arbor



(b) Section through dynamometer

Electronic Circuits (Fig. 3)

A tuned grid triode oscillator, V_1, supplies a signal to the differential transformers via V_2. The circuit is fed with a stabilized h.t. supply of 150V d.c.

The right-hand side of the circuit diagram is the metering circuit, the signal from the differential transformer being received at A, then fed through a triode amplifier, V_3, to a transformer which forms part of a phase-sensitive rectifier circuit. The reference voltage B, supplied to the grid of V_4, is used as the other supply to the rectifier circuit. Centre-tappings from the two secondaries are connected to a voltmeter, oscilloscope, or recorder where the signal finally registers. If the speed of fluctuation is great, an oscilloscope and camera must be used for recording the signal.

Design Considerations

Enamelled copper wire formed the coils of the primary and secondary windings, these being impregnated with 'Durofix' to hold them solid.

The transformer core and pole pieces were made of silicon iron, the laminations being glued with 'Durofix' to provide solidity and a high resistance path at the interfaces. Core and pole pieces were assembled on a dummy arbor, and a torque applied in a torsion machine to check the extent of the electrical signal. The results are shown in Fig. 4. From these it was seen that the provision of a second transformer mounted diametrically opposite the first to intensify the signal, would not be necessary.

Following this, the arbor was subjected to successive impacts to see if the coil assembly would shift or vibrate. There was no coil vibration. Had there been any, the whole core and coil assembly could have been set immovably in a block of epoxide resin. This measure might still be taken in later versions of the instrument.

Brushes of silver solder contacted brass sliprings grooved to receive them. The sliprings were carried on Perspex collars clamped on to a duralumin rider which was a smooth sliding fit on the arbor. Silver plated rings were not used in the first model since the voltage loss at the rings proved small in comparison with the signal.

Test Runs and Oscillography

During the development stage an oscilloscope fitted with a long persistence tube was used to examine the signal. Since the experiments were carried out during the day, the persistence of the trace on the screen was not sufficient to allow the use of tracing paper directly applied to the screen as had been hoped for. Instead, the image had to be photographed.

For this purpose the horizontal scan of the tube was slowed. By duplicating part of the internal time-base circuit of the oscilloscope externally, and incorporating a switch in parallel with the capacitor in this circuit, it was possible to release single pulses, the beam slowly traversing the screen as the capacitor charged. The pulses were released with the cutter under load. The camera, which with shutter open was focused on the screen from the

other end of a tubular light-tight box, recorded both the trace during cutting and the horizontal baseline trace when the feed was discontinued and the capacitor discharged to return the beam. Although the rate of scan of the beam across the tube was not uniform, depending upon the non-linear rate of charge of the 8μF capacitor usage, and was representative more of the standard machine tool likely to be found in any machine shop than the special tool kept solely for testing purposes in a machine tool laboratory. Due to wear the feed of the machine was in regular surges, and the trace showed humps characteristic of this defect. At the position of

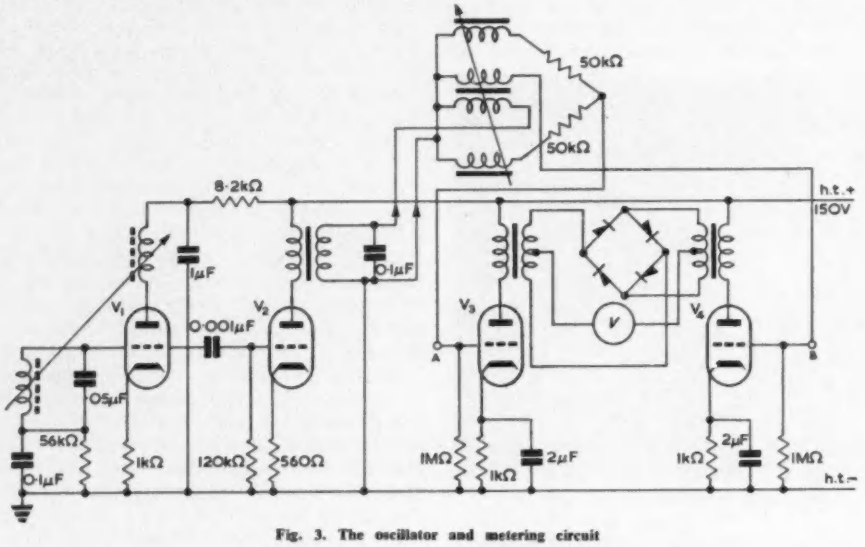


Fig. 3. The oscillator and metering circuit

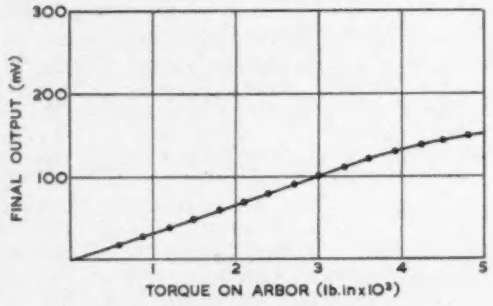


Fig. 4. Output test on assembled rig

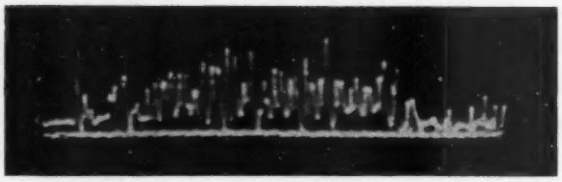


Fig. 5. A typical oscilloscope trace

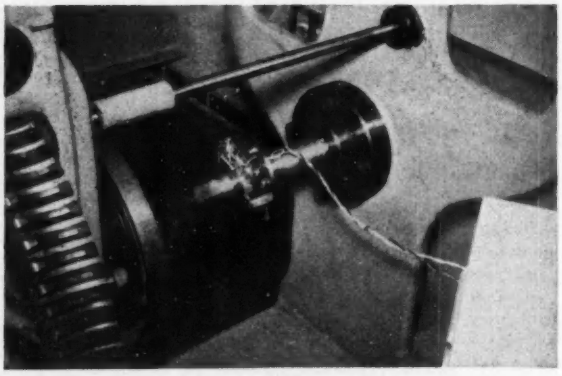


Fig. 6. Calibration of tube by static straining of dummy arbor

in the external circuit, the results obtained were good enough for comparative analysis, a typical trace is shown in Fig. 5.

Calibration of the tube was by static straining of the dummy arbor in the torsion machine, the beam being triggered at each position of strain (Fig. 6).

Examination of the traces showed that it would be possible to employ a recorder with a frequency response of 100c/s. A Kelvin Hughes dynamic strain recording unit was coupled into the circuit in place of the oscilloscope, and with this instrument it was possible to feed the outer limbs of the E-shaped core directly, giving two balanced inductances. The unbalance of these inductances under strain of the mandrel was measured by the recorder.

Typical Results

The tests were carried out on a machine which had been in use for six years in the College workshop. It had been subject to the normal wear and tear of student feed where the teeth disengaged, vibrations of cutter and table resulted in pronounced oscillation, an effect which had its results in a noticeably wavy finish on the approach surface of the work. Fig. 7 shows two recorder traces, one for a $\frac{1}{2}$in side and face cutter, the other for a 2$\frac{1}{2}$in roller mill with helical teeth.

It can be seen that without helical teeth the cutting

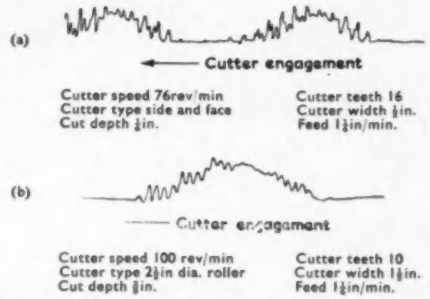


Fig. 7. Recorder traces from cutting of side and face cutter (a) and roller mill (b

torque is much more irregular than with helical teeth. This is to be expected, since the 'snatch' effect is much less.

By using a planimeter to integrate the area under the recorded trace, the horsepower absorbed in cutting is easily found. This result is not affected by any oscillation of the cutter or table. Indeed, a good part of the experiment is to draw the line of cutting torque, and distinguish the characteristic oscillation of the arbor as a vibration additional to this. This vibration, and its possible effects on surface finish, can be investigated. The apparatus can also be used to demonstrate the effects of 'climb cut' and 'up cut' milling on torque, vibration, and horsepower absorbed.

An Electronic Seat Reservation System

A contract has been placed by the British Overseas Airways Corporation with Standard Telephones and Cables Limited for the supply and installation of an electronic system which will provide ticket selling offices throughout U.K. and Europe with up-to-the-minute information on the availability of airline seats on all flights operated by B.O.A.C. The system will also give information on the flights of other airlines associated with B.O.A.C.; in each case the information will be available for flights over a period up to 20 weeks ahead.

Initially, a central magnetic drum store of flight information in Airways Terminal, Buckingham Palace Road, London, will serve about 100 sales personnel using special keying sets within the Terminal Building itself. It is planned that this installation will be ready for service in the latter part of this year. Later, the system will be extended, using telegraph circuits, to various points in London including London Airport.

Further geographical extensions over standard telegraph channels will be made quickly to large centres in the United Kingdom such as Birmingham, Belfast, Manchester, Leeds, Glasgow and then to a number of cities in Europe.

There are four main parts to the system:

(a) *The Sales Clerk's Desk Set:* there will be a large number of these sets at Airways Terminal and at sales offices throughout the U.K. and the continent.

(b) *The Controller's Desk Set:* there will be several of these sets at the central control point in Airways Terminal.

(c) *The Supervisor's Console:* in Airways Terminal.

(d) *The Information Store:* in Airways Terminal.

The Sales Clerk's Desk Set

Each sales clerk within the system has access to a push-button unit for interrogating the computer store. He has a set of "flight plates" which are thin metal plates with standard flight information printed on both sides. These plates are supplied periodically from the control centre and show the pattern of flight information for 20 weeks ahead.

When the clerk receives an enquiry he selects the appropriate plate, which contains details of related flights, and inserts this into the desk unit. Notches in the plate operate microswitches in the unit and identify the plate and the side which is being studied.

The clerk then presses buttons on his desk unit corresponding to the departure and arrival points on the sector of the route in question. He also presses buttons corresponding to the date and class for which a booking is required.

Having thus set up the interrogation formula he presses his ASK button which sends this interrogation code at high speed to the central processing equipment. This information store can indicate one of three conditions for each flight on the flight plate: 'open for sale', 'request' (i.e. where limited seats only are available) and 'waiting list'. These replies show up as a pattern of lamps on the clerk's unit as green, red/green together, or red respectively. A fourth condition where no lamps are lit indicates that the flight for various reasons is not available for sale. The availability status of up to 10 flights per interrogation on a given plate can be brought up for consideration by the clerk simultaneously. For example, where 10 flights operate to a common destination on the day interrogated the seat availability situation on these 10 flights will be presented simultaneously.

The mode of interrogation is extremely simple and enables the sales clerk to offer alternative available accommodation where that originally required by the passenger is not available. Ascertaining seat availability conditions on adjacent dates is carried out by merely depressing the new date button. Details of the transaction are then sent to the appropriate space control unit by telegraph messages where they are converted into orthodox punch card records.

The Control Clerk's Desk Set

The control clerks are located in Airways Terminal and are responsible for keeping the status information for all flights up to date in the magnetic drum information store. These clerks note incoming bookings and cancellations and when a flight is fully booked or booked up to a predetermined figure, they change the flight status information in the drum store accordingly.

The control clerk's key set is similar to that of the sales clerk but has additional buttons for feeding the magnetic drum of the information store with "coloured light" status on any or all of the flights on any flight plate.

By pressing his ACT button, the control clerk cancels the existing information in the drum store and 'writes-in' the new status information so that sales clerks' interrogations will always yield the correct answers.

The system permits the control clerk to revise flight status in approximately one second and from this moment the revised information is available for any subsequent interrogation throughout the network. The ability to reopen a fully booked flight on which a number of cancellations have been encountered represents one of the most substantial benefits to B.O.A.C. from installing this system.

The Supervisor's Console

The supervisor's console contains keys which enable him to initiate any of 12 different computer programs. Two programs have been described: these are initiated by the sales clerks and control clerks when they press the ASK and ACT buttons. The supervisor's equipment includes a key set for amending and checking information stored in the drum.

The other main programs initiated by the supervisor are:

Automatic daily up-dating of availability information as each day's flights become redundant.

Storage of address and 'open for sale' condition when new flights are included.

Verification procedures for checking the positions and alignment of information on the drum store.

The Information Store

Two drums will constitute the Information Store.

The drums to be used have 1 000 bit positions on 320 tracks. This method of storage allows simultaneous reading and writing on many tracks.

Flight status records are written along drum lines each of which consists of a number of track positions along a common angular position. The length of a record is therefore determined by the number of tracks which it occupies.

The central electronic assembly is fully transistorized and the power supplies are specially stabilized.

COLD-CATHODE TUBE CIRCUITS FOR AUTOMATION

By R. S. Sidorowicz*, A.M.I.E.E.

(Part 3)

(Voir page 196 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 203)

Oscillators and Multivibrators

An important function in automation systems is performed by cold-cathode oscillators and multivibrators, especially when their operation can be controlled by an external signal (pulse, bias or anode voltage). Such circuits may perform a purely auxiliary function, such as testing the operation of the equipment, or they may be switched on for the purpose of generating a specified number of pulses. Further, sometimes they may be required to generate a time waveform (clock pulses) if their stability is deemed sufficient.

The simplest oscillator is shown in Fig. 26. This circuit was described in detail in an earlier article[15]. Here, it will only be mentioned that the oscillator gives output pulses of about 50V amplitude and its maximum operating frequency (with R = 3·3MΩ and C = 0·01μF) is about 50c/s. The operation of the circuit can be controlled by connecting R to the anode of a capacitively coupled binary of the type shown in Fig. 11.

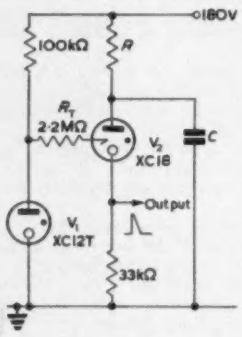


Fig. 26. Simple relaxation oscillator

A more complex oscillator is shown in Fig. 27. This consists of a univibrator (V_1, V_2 and V_3) and a pulsing tube (V_4) whose charging network RC is controlled by the anode voltage of V_3. The trigger-cathode gaps of V_2 and V_4 are permanently kept aglow by the voltage provided from the anode of V_1. The operation of the circuit is as follows. When V_2 is conducting, V_3 is extinguished and its anode voltage is V_b = 180V. The capacitor C of V_4 is therefore charged through R. When the voltage on C reaches a suitable potential, V_4 fires and produces a pulse across its cathode resistance. The pulse ignites V_3 and results in the extinction of V_2. Also, V_4 is extinguished because its anode potential is reduced to V_{am}. However, V_3 re-ignites when its anode voltage reaches V_{as}. Consequently, V_3 is extinguished and C can charge again until V_4 breaks down. The output pulse produced at the cathode of V_4 has an amplitude of about 50V. With the values of the components indicated in the diagram the circuit operates at a frequency of about 3c/s. The minimum values are R_{min} = 220kΩ and C_{min} = 0·01μF; with these the oscillator operates at about 200c/s. The trigger biasing resistance R_T can be varied from 1·0MΩ to 2·2MΩ.

* Hivac Ltd

It should be realized, however, that the amplitude of the output pulse is to some extent affected by the value of R_T.

A simple multivibrator circuit is shown in Fig. 28. The circuit is based on a capacitively coupled binary, except that the triggers of both the tubes (V_2 and V_3) are kept permanently aglow. When the supply voltage is switched on, the trigger of V_2 is struck first, since it immediately receives the full voltage. V_2 is therefore ignited and its anode voltage becomes V_{am} = 70V. V_3 becomes conducting a few milliseconds later, since its trigger voltage is 'slowed-down' by the presence of the 0·005μF capacitor. When V_3 fires, V_2 is extinguished due to the presence

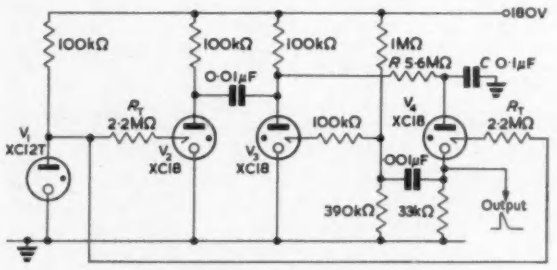


Fig. 27. Oscillator based on a monostable binary

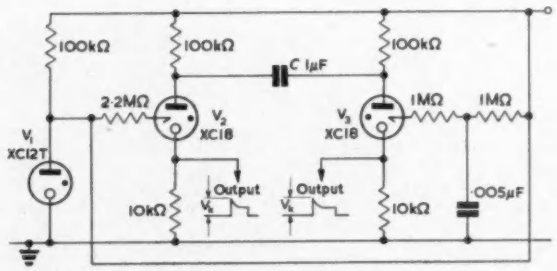


Fig. 28. Two-tube multivibrator

of the quenching capacitance C. However, the voltage at the anode of V_2 gradually rises until it reaches the striking potential V_{as} of the tube. Consequently, V_2 refires and V_3 is extinguished. Again, when the anode voltage of V_3 reaches V_{as}, V_3 becomes conducting and V_2 is extinguished. The circuit is not suitable for work with cold-cathode circuits, because its peak output amplitudes (taken across the cathode resistors) are about 20V. The frequency of the oscillator can be varied by changing C. With the values indicated in Fig. 28, the frequency is about 4c/s. The lowest possible value is C = 0·01μF which gives the maximum frequency of 250c/s.

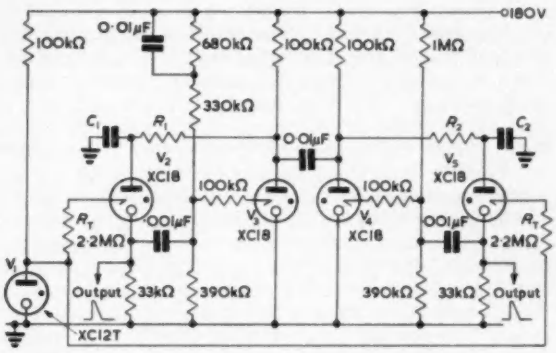


Fig. 29. Four-tube symmetrical multivibrator with two pulse outputs

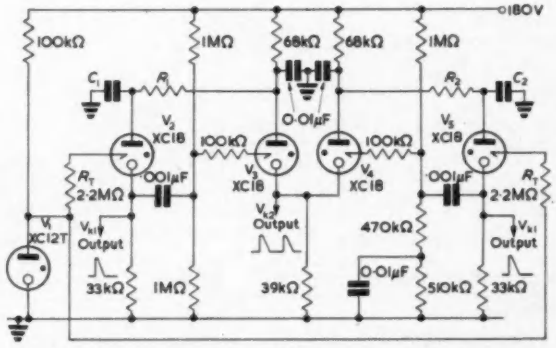


Fig. 30. Four-tube symmetrical multivibrator with three pulse outputs

A multivibrator with two pulse outputs is shown in Fig. 29. The circuit consists of a capacitively coupled binary (V_3 and V_4) and two pulsing tubes (V_2 and V_5) whose triggers are permanently ignited by the anode voltage of V_1. When the supply is switched on, V_3 is instantly ignited since its trigger voltage temporarily rises to above 90V. The voltage across the anode capacitor C_2 rises to V_{aa} at which V_5 fires. A pulse is therefore produced at the cathode of V_5 and this fires V_4. The ignition of V_4 results in the extinction of V_3, whereupon the anode capacitor of V_3 is charged through R_1 from the anode of V_3. When the voltage across C_1 reaches V_{aa}, the pulsing tube V_2 becomes ignited and the pulse produced across its cathode resistor restrikes V_3. Consequently, V_4 is extinguished and C_2 is charged again until V_5 strikes. The output pulses of the multivibrator have an amplitude of about 50V. With $R_1 = R_2 = 220k\Omega$ and $C_1 = C_2 = 0{\cdot}01\mu F$ (these are roughly the minimum values) the multivibrator oscillates at about 150c/s.

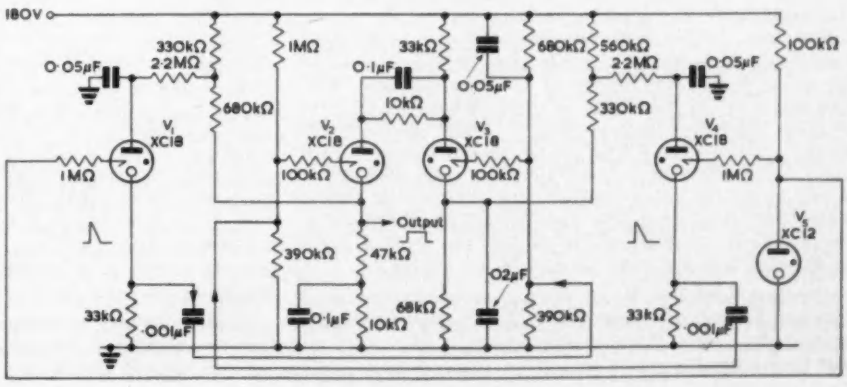
A multivibrator with three separate pulse outputs is illustrated in Fig. 30. It employs two pulsing tubes (V_2 and V_5), whose triggers are permanently primed through R_T from the anode of V_1, and a resistively coupled inverted binary (V_3 and V_4). When the circuit is switched on, V_3 is first ignited since its trigger receives higher initial voltage than that of the trigger V_4. A potential of about 40V is therefore established across the common cathode resistance ($R_k = 39k\Omega$). The capacitor C_2 is now charged through R_2 from the anode of V_4. When the voltage across C_2 reaches $V_{aa} = 130V$, the pulsing tube V_5 fires and a pulse is produced across its cathode resistor. This fires V_4 and results in the extinction of V_3. The charging and ignition process is now repeated in the pulsing circuit of V_2. This results in the re-ignition of V_3 and the extinction of V_4. For each pulse produced at the cathodes of V_2 and V_5, a pulse is generated across the common cathode resistance of the binary. The output amplitudes of the pulsing tubes are about 50V, while the pulses of the binary have an amplitude of about 65V. The minimum permissible values of the components are: $R_1 = R_2 = 1{\cdot}0M\Omega$, $C_1 = C_2 = 0{\cdot}01\mu F$; with these values the multivibrator operates at about 70c/s.

A free-running square-wave generator is shown in Fig. 31. The circuit is based on a pulsing binary (V_2 and V_3) of the type shown in Fig. 13 and two pulsing tubes (V_1 and V_4) whose charging networks are connected to the cathodes of V_2 and V_3. The triggers of the pulsing tubes are permanently primed from V_5. When the circuit is switched on, V_3 is first ignited and its cathode voltage rises to about 70V. The potential of the point between 680kΩ and 560kΩ is thus also raised and the anode capacitor of V_4 gradually charges to the voltage $V_{aa} = 120V$, at which V_4 breaks down and generates a pulse at its cathode. The pulse ignites V_2 and results in the extinction of V_3. Now the anode capacitor of V_1 charges to V_{aa}. When V_1 fires it produces a pulse at its cathode, which re-ignites V_3 and causes the extinction of V_2. The circuit generates almost rectangular pulses at the cathode of V_2; the rise-time of the pulses is of the order of several microseconds; the trailing edge of the pulses is equally steep except for its lower portion (about ¼ of the total amplitude) which decays exponentially with the time-constant of 1·0msec. The amplitude of the pulses is about 50V. With the values of the components indicated in Fig. 31, the generator operates with the mark-to-space ratio of 1:1 and produces pulses of 50msec duration.

Numicator Drive Circuit

In general the Numicator tube will be used as a digital indicator of the state of a counting decade. However,

Fig. 31. Free-running square-wave generator with three outputs



special tubes with letters, 'plus' and 'minus' signs or decimal points are possible. These tubes require a special drive circuit. Sometimes it is possible to design a special counter decade which will drive a digit tube directly, but very often it is necessary to employ 10 additional tubes apart from the counter. Several different drive circuits for digital read-out tubes have been described by H. Liebendörfer[21] and McLoughlin and others[22]. However, these are not suitable for working with the tubes indicated in Table 1.

A digital-tube drive circuit based on the cold-cathode triodes, type XC18, is shown in Fig. 32. The circuit consists of a counting decade similar to that of Fig. 14, except that the cathode resistances are increased to (56 + 27)kΩ, the anode resistance is reduced to 22kΩ and the cathode capacitors are 0·02μF. The first tube of the decade is an XC24, one of whose triggers is used for the purpose of igniting the tube when the circuit is switched on. The voltage generated at the cathodes of a conducting tube in the decade is in excess of 80V. This voltage is applied through 1·0MΩ resistor to the trigger of the corresponding drive tube which is connected in series with one of the cathode-anode gaps of the Numicator. The voltage at the trigger is sufficient to establish a discharge between the cathode and the trigger, so that the anode breakdown voltage of the tube is about 130V. The anode of the Numicator is supplied with a half-wave rectified waveform derived from a 250V mains transformer. Consequently, the gap of the Numicator which is in series with the primed auxiliary tube, will break down during the appearance of each peak of the supply waveform. The remaining gaps remain non-conducting. By shifting the position of the primed tube, various digits in the Numicator can be selected in succession.

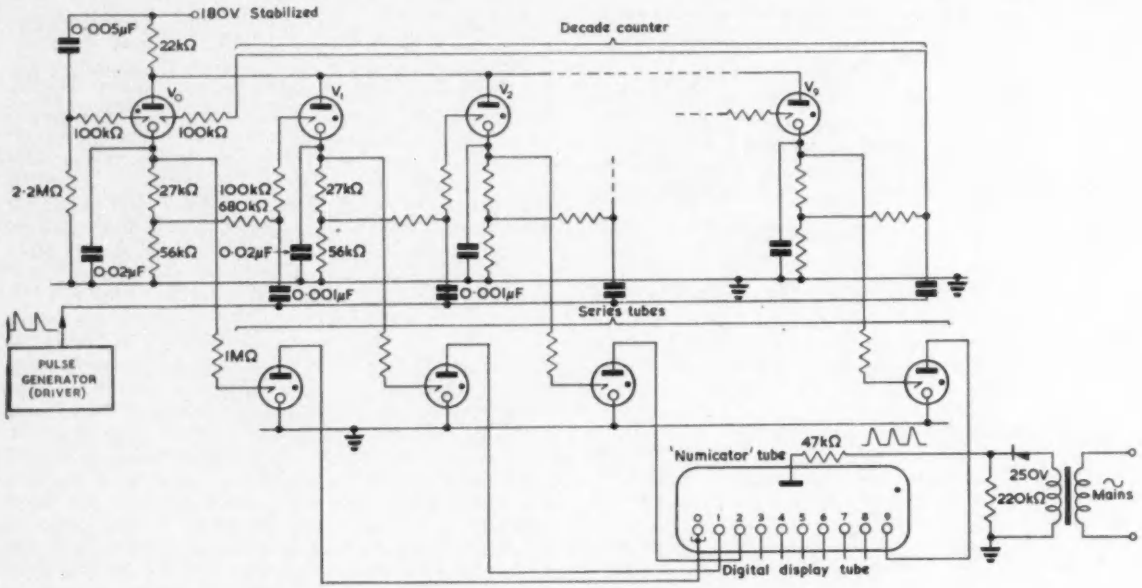


Fig. 32. 'Numicator' drive circuit

The decade of Fig. 31 can operate at frequencies up to 250c/s. Though the Numicator cannot follow that speed (due to the nature of its anode supply), a clear read-out will be provided once the counter is stopped on a particular digit. The circuit of Fig. 32 employs a relatively large number of tubes. However, it is a comparatively simple circuit in that it is based entirely on cold-cathode tubes and requires but little auxiliary equipment (half-wave rectifier).

Some Applications - Examples of Cold-Cathode Tube Systems

The circuit elements described in the preceding sections can be used to design a variety of systems. The number of cold-cathode tubes employed in these systems may range from tens to hundreds or, perhaps, thousands. It is not possible, however, to answer even approximately the question as to what extent automation on the basis of the cold-cathode tube circuits is technically feasible and economically justifiable. It is clear that in those situations where large quantities of information have to be evaluated in a very short time, the cold-cathode circuits will prove inadequate except, perhaps, as auxiliary devices. In other words, the circuits may prove inadequate in high-speed computers. On the other hand, such problems as automatic batching, machine positioning, electronic inspection, automatic safety control and process timing can be dealt with satisfactorily by means of cold-cathode tube circuits.

The reliability of the circuits, if properly designed, should not be inferior to that of other electronic devices and their life should be compatible with that of most machines. Since cold-cathode tubes are comparatively insensitive, very little trouble is to be expected from interstage pick-up provided that long sections of wires are not indiscriminately bunched together. It should also be mentioned that where cold-cathode tubes are used to operate relays, it is necessary to suppress the inductive surges which occur when a relay is switched off.

In the following an attempt will be made to show how the circuit elements can be combined into systems which may be suitable for solving automation problems.

Electronic Dial

A comparatively simple device capable of generating a preset number of pulses is shown in Fig. 33. The device consists of a control counter, a pulsing univibrator and a delay circuit. When the supply voltage is switched on, the circuit automatically assumes its 'zero' position. This is characterized by tubes V_B, V_E and V_I being ignited and the triggers of V_C and V_D being primed from the reference diode, type XC12T. Upon pressing the 'start key', V_A is ignited and V_B is extinguished. The voltage of the charging network of V_C is therefore raised and V_C produces a train of pulses which successively ignite the tubes of the control decade. When a pre-selected tube of the decade (V_2 in Fig. 33) becomes conducting, a bias voltage from its cathode resistor is simultaneously applied to V_B and V_F. Consequently, the next pulse from the cathode of V_C fires V_B, V_F and the next tube in the decade. The pulsing is therefore terminated and, after a delay of a few milliseconds, a pulse is produced at the cathode of V_D. The pulse re-ignites V_E and V_I and the circuit is therefore returned to its initial position.

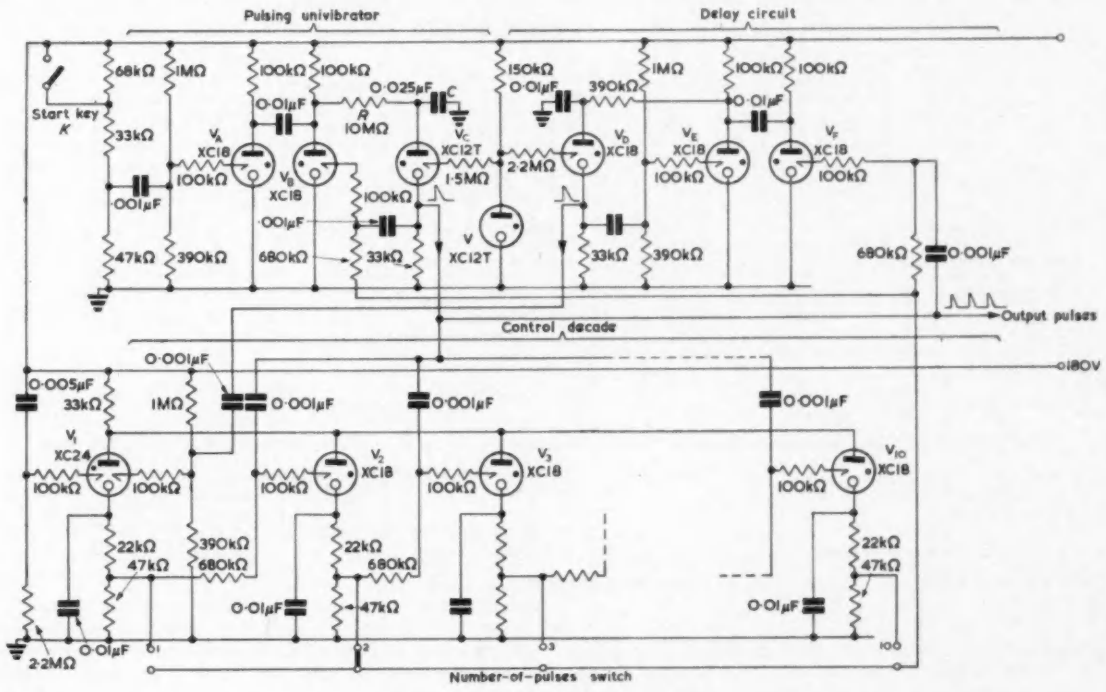


Fig. 33. Electronic dial

A number of pulses obtained at the cathode of V_C can be controlled by the 'number-of-pulses switch'. If more than ten pulses are required the control counter chain can be extended. The maximum speed obtainable from the circuit (with $R = 3{\cdot}3\text{M}\Omega$ and $C = 0{\cdot}01\mu\text{F}$) is about 50 pulses/sec.

Controlled Counters

The operations such as batching, machine positioning and process timing can be carried out by cold-cathode tube counters, if the latter are furnished with suitable control circuits. In the case of batching a pulse has to be produced for each object passing through the system. The pulse can be generated by a mechanical switch or by a photocell. In machine positioning it is necessary to establish a linear relationship between the number of pulses fed into the counter and the distance traversed by a tool of the machine. It may be convenient to generate the pulses by means of a slotted disk (acting as a light interrupter) which is attached to the co-ordinate drive motor of the machine. When used as a timer the counter acts as a preset frequency divider. It is driven from a clock pulser which generates a train of equi-distantly spaced pulses. In many applications it may be sufficient to use the mains voltage (50c/s) as the timing waveform. However, when greater accuracy is required, the timing waveform can be generated by a stable audio frequency oscillator.

A method of building up a controlled counter is illustrated by the block schematic of Fig. 34. Basically, this represents a batch counter, but with some modifications it can be used as a position controller or a process timer.

In describing the system it will probably be best to mention first what the system can do and then describe how it is done. The objects to be 'processed' by the counter of Fig. 34 are grouped into batches of two sizes, *A* and *B*. The size of a batch can be varied from 1 to 99 by means of two decade switches. The sequence of batching up to 10 batches can be controlled by means of a set of switches; for instance the batches can be arranged in the following orders: *AABABAAABB*, or *ABABAB-AAAB* etc. An output pulse is produced at the termination of each batch and the number of batches (up to ten) is recorded on a counter. After executing the programme, that is counting ten batches in a pre-selected order, the

system produces a pulse which can be used to block its input stage and thus terminate the counting process. The 'end-of-batch' and 'end-of-programme' pulses can be employed to control the operation of the mechanical system which handles the objects that are being batched.

The batching counter consists of the following units: a gating binary (similar to that of Fig. 12), a pulse amplifier which is gated by the binary (see Fig. 3), two delay circuits (see Fig. 7), gated pulse amplifiers *A* and *B* (see Fig. 3), two *X* AND *Y* circuits (see Fig. 22), an *X* OR *Y* OR *Z* circuit (see Fig. 19), an *X* OR *Y* circuit (see Fig. 19), two counting decades (see Fig. 14), a ten-position shift matrix (see Fig. 24), and an additional counting decade (see Fig. 14). The system is also fitted with a simple 5c/s oscillator and a push-putton operated pulser which are employed for testing and checking.

When the system is switched on, all the circuit elements are automatically set in their zero positions. The gating binary is set so that no bias is applied to the gated amplifier and, consequently, the system is blocked. It can be made operative by triggering the binary. The pulses from an external source (or the oscillator) are then shaped in the gated amplifier and actuate two delay circuits ($T_1 = T_2 \simeq 3$msec). The pulses from the amplifier also drive the units decade and, through the terminal stage, the tens decade. The pulses from the first delay circuit are applied to the gated amplifiers *A* and *B*; only the the amplifier which receives a bias voltage from the shift matrix produces output pulses. The biases from the cathode circuits of the units decade and the tens decade are applied to two reset circuits which are in the form of *X* AND *Y* logic gates. The output pulses from the reset circuits are combined in the *X* OR *Y* logic circuit and in the *X* OR *Y* OR *Z* circuit, where the third input is taken from the terminal stage of the units decade.

Assume now that the first reset circuit is set at 75, that is one of its bias inputs is connected to the 7th cathode circuit of the tens decade and the 5th cathode of the units decade; reset circuit *B* is set at 43. Further, initially only the gated amplifier *A* is biased. As the pulses are applied to the two decades, the position of the conducting tubes is gradually shifted forward. After every ten pulses the units decade is returned to its zero position. After 75 pulses the reset circuit *A* is biased at both its inputs. It is therefore triggered by the delayed pulse from the amplifier *A* and then restored to its original position by the pulse from the second delay circuit. As a result of this operation an output pulse is produced by the reset circuit; this is applied to the two OR circuits. Now the output pulse from the *X* OR *Y* OR *Z* circuit resets the counter to zero. The resetting occurs at about 6msec after the termination of the 75th input pulse. The output pulse from the *X* OR *Y* circuit shifts the matrix by one step forward and operates the 'number-of-batches' counter. If, after the termination of this batch ($A = 75$), the matrix is again biasing the amplifier *A*, another batch of 75 will be counted. However, if the amplifier *B* is biased (and the amplifier *A* is inoperative), the count will be terminated by the reset circuit *B* after the acceptance of 43 pulses. Further input pulses are batched in accordance with the sequence preset on the shift matrix. After ten batches the matrix is restored to its initial position and a pulse is produced by the terminal stage of the 'number-of-batches' counter. The programme of batching can now be repeated, or the output pulse from the batch counter may be used to reset the input binary and thus block the system.

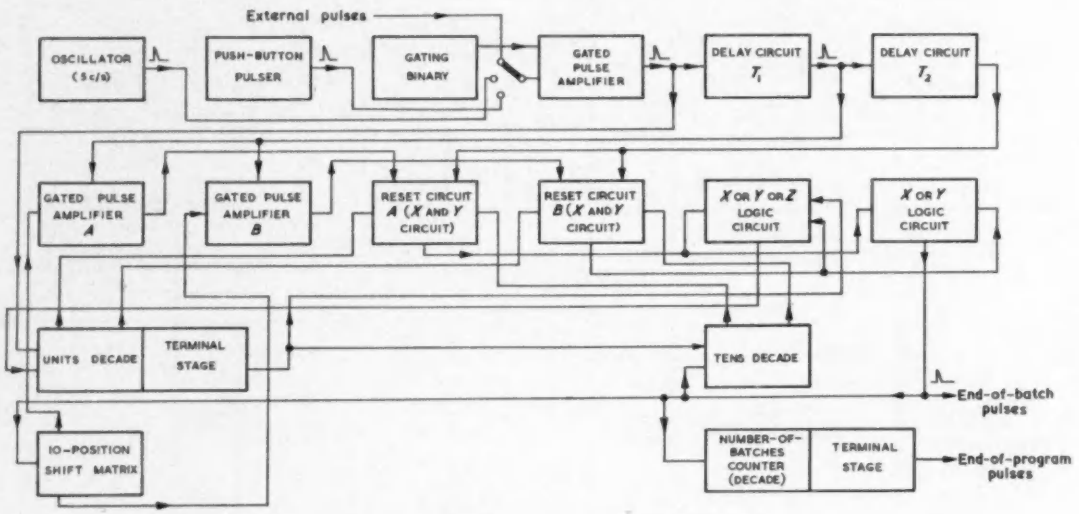


Fig. 34. Programmed batch counter

The batching counter of Fig. 34 can be extended easily. In particular, it is possible to introduce additional reset circuits, if more than two batch sizes are required. In this case it is necessary to 'expand' the matrix vertically, unless the batches are to be counted in a fixed order and the matrix can be dispensed with altogether. By adding more counting decades it is possible to increase the size of the batches, but the reset circuits should be 'expanded' so as to accommodate more inputs (see Fig. 23). The counter of Fig. 34 can operate at speeds up to 100c/s, which will be adequate in most automation systems.

The counter can be used, almost without modifications, as a process timer. For this purpose a train of timing pulses (repeated for instance at the rate of 10p/s) is applied to the input amplifier. The first pulse of the train can

initiate a process. This will continue until the counter is reset by one of the reset circuits. Another process whose duration is controlled by the other reset circuit may then be initiated. The two processes can be repeated in accordance with the sequence pre-determined by the matrix. More complex timing sequences can be arranged by providing the counter with additional reset circuits and expanding its matrix. However, if only a fixed sequence of timing processes is required, it is possible to dispense with the matrix and employ a simple counter for providing the biases to the gated amplifiers. In general, the 'batches counter' will not be necessary in a process timer.

The principle illustrated in Fig. 34 can be used to design an equipment for the co-ordinate positioning of machines, but it appears that in this case it will be advisable to employ a reversible counter. This will probably necessitate the increase in the number of logic circuits for each control stage.

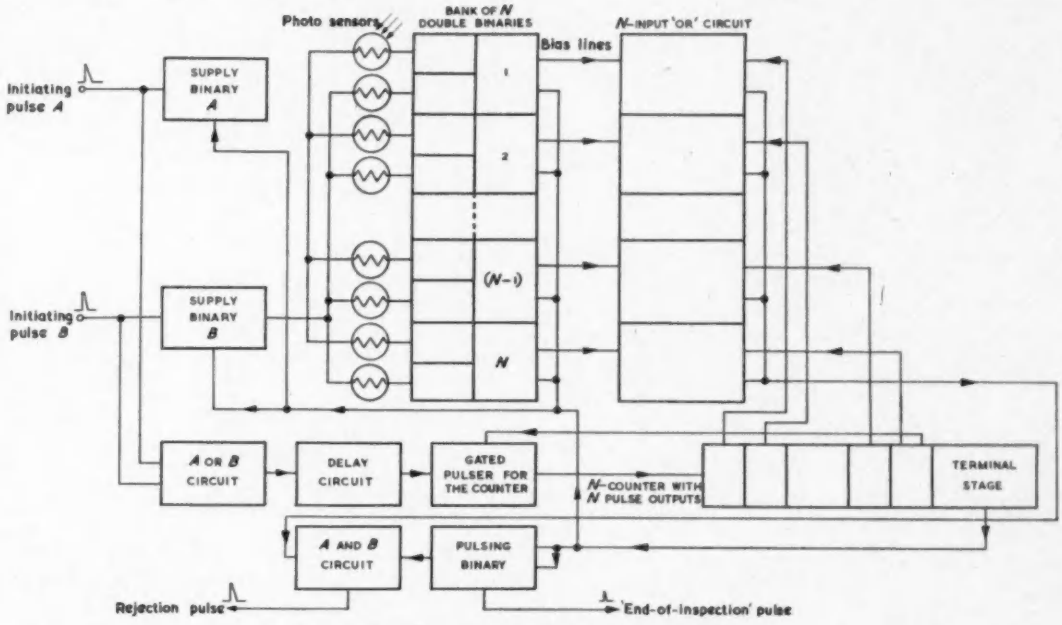


Fig. 35. Double inspection device with photo-electric sensors

Electronic Inspection Unit

An example of the application of the cold-cathode tube circuits to automatic inspection is shown in Fig. 35. The equipment performs the following functions. When the object to be inspected moves into a suitable position, a starting pulse A is produced. This switches on a set N of photo-resistors (photo-sensors). The object then moves into a different position and another starting pulse is generated which switches on another set of N sensors. If all the sensors in both test positions receive correct illumination, the tested object is passed on as satisfactory. If the output of one of the photocells is low, the object is rejected.

The inspection unit of Fig. 35 consists of the following elements: two binary supply circuits based on XC23's (see Fig. 11), two sets of photo-sensors of N elements each, a bank of N double-binary circuits, an N-input OR circuit (see Fig. 18 or 19), an A OR B circuit (see Fig. 18), a delay univibrator (see Fig. 7), an N-pulse counter with N pulse outputs (see Fig. 17), a bias-gated pulser (see Fig. 33), a pulsing binary circuit (see Fig. 13) and an A AND B logic gate. A detailed diagram of the double-binary circuit with photo-sensors is shown in Fig. 36.

The operation of the system is as follows. When the first supply binary is actuated by the initiating pulse A, a potential of about 180V appears across the first set of N photo-resistors. If the photo-elements are suitably illuminated, voltages higher than V_{tb} (trigger breakdown

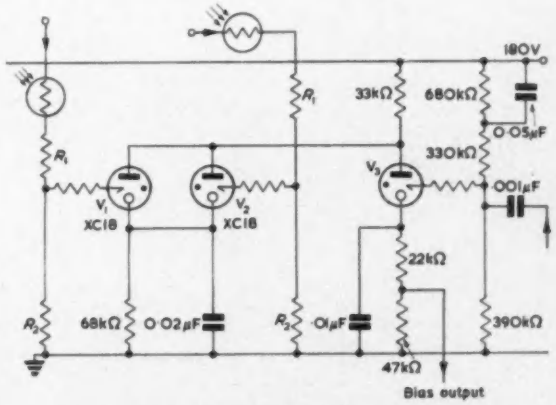


Fig. 36. Double-binary circuit actuated by photo-resistors

potential) will appear across the resistors R_2 of the photo-element load (see Fig. 36). These voltages will ignite one set of left-hand tubes in the bank of the double binaries (see Fig. 36) and result in the extinction of the right-hand tubes. The biasing voltages will therefore be removed from the N-input OR circuit. A delayed pulse is then produced by the univibrator. This will actuate the gated pulser and result in the generation of N pulses at

N cathodes of the counter. The pulses will scan the N-input OR circuit, but since all the biases are removed, no output pulse will be produced. The terminal stage of the counter will reset the whole circuit and also actuate the pulsing binary. However, if at least one of the photo-resistors is not adequately illuminated, the bias will be left on one input of the OR circuit and a pulse will be produced which will actuate the A AND B circuit.

When the 'scanning' of the first set of photo-resistors is completed, the second initiating pulse can be applied. The second set of photo-sensors is thus switched on and the scanning process is repeated. Again, if one of the photo-sensors 'reads' low, a pulse will be produced by the OR circuit. When the second scanning is terminated all the circuits of the system are reset to their original position. A pulse is therefore produced by the pulsing binary; this pulse marks the termination of the inspection process. The pulse will also reset the A AND B circuit, if it has been triggered by the pulses from the OR circuit, and thus produce a rejection pulse. The 'end-of-inspection' and rejection pulses can be used to control the further handling of the tested object (through suitable relays).

It may be mentioned that it is not necessary to have N photo-resistors in each inspection set. For instance, there can be N cells in the first set and M elements in the second set ($N > M$). However, the number of binaries will have to be N, except that $(N - M)$ of them will contain two tubes (instead of the normal three). If sub-miniature cadmium-sulphide cells are used as photo-sensors, one supply binary based on a pair of XC23 can easily feed up to 10 cells. It should be clear that for $N > 10$, it is possible to include two or more supply binaries. The delay between the starting pulses and the commencement of the scanning should be about 0·1sec. This is principally due to the considerable inertia effects exhibited by the CdS photo-resistors. If a gated pulser of the type shown in Fig. 33 is employed in the inspection unit, the maximum scanning will be about 30 to 40p/s. The speed can be increased by using a modified version of one of the faster oscillators (see Figs. 27 and 29).

At this stage it may be convenient to add a few general remarks on the design of automation systems based on the cold-cathode circuits. Obviously, the first requirement is that the designer should be thoroughly conversant with the circuits. Secondly, it is necessary to know exactly what a given system is required to do. This condition is not as easy to meet as it may appear, since more often than not a designer may be handed a rather vague specification by somebody who is not fully aware of the possibilities offered by electronics. The next stage in the design will consist of dividing the system into a number of suitable functional units. Each unit will then be designed in detail. Next, the whole system thus designed is reviewed and an attempt is made to introduce as many simplifications as possible. It will generally be found that during the reviewing of the primary design, the number of circuit elements and tubes will be reduced quite appreciably. It may then be advisable to subject the systems to another revision.

As a matter of curiosity it may be mentioned that a fairly obvious, though not particularly significant, simplification can be introduced in the batching counter of Fig. 34. No doubt, the reader will have little difficulty in spotting the redundant element.

TABLE 2

CHARACTERISTIC	DETAILS
Functions ..	Amplification, delaying, pulse combining, counting, waveform generation
Components ..	Subminiature and miniature cold-cathode tubes Resistors: mostly ½W dissipation, ±5% tolerance Capacitors: 250V d.c. working, ±20% tolerance
Speed	100c/s average (500c/s maximum)
Supply source	+180V stabilized
Input devices	Contactors, switches (limit, proximity, micro); photocells
Output devices	Relays, power valves and thyratrons
Applications ..	Batching, timing, co-ordinate positioning, inspection, safety devices
Special features	Self-indicating, self-starting

Concluding Remarks

It will be convenient to summarize the main characteristics of the circuits and the systems built from them. This is done in Table 2. A few words of clarification may be necessary as regards the self-starting feature of the circuits. It was mentioned that all the circuits set themselves into their rest position upon being switched on. However, some of the circuits produce pulses when they are first switched on. In a system consisting of a number of circuit elements, these pulses will be applied to various tubes. If it happens that some of these tubes receive a bias voltage on being switched on, an undesirable firing of the tubes may occur. The situation can be remedied by dividing the circuits into two groups. First, all the circuits which generate pulses are switched on, and then (after a suitable delay) all the remaining circuits. Alternatively, it is possible to arrange by means of RC networks that the biases to those tubes which are likely to be triggered are suitably delayed.

It is seen that all the circuits are provided with trigger resistors (usually, 100kΩ). Very often these resistors are omitted and, indeed, the life of the tubes will not be significantly affected by this simplification. However, it is necessary to point out that by omitting the resistors, the load on all the pulse sources will be increased.

When designing a cold-cathode tube system it may be advisable to include some simple test facilities. These will usually take the form of a simple relaxation oscillator or a push-button-operated pulser (see Fig. 34). Such auxiliaries may prove very valuable in that the system can be slowly tested stage by stage and visually inspected. Also, the oscillator can be employed to carry out the preliminary ageing of the equipment in order to eliminate the initial failures of the components.

The article has been primarily concerned with what may be referred to as 'large-scale applications' of cold-cathode tube circuits. It is therefore necessary to point out that the circuits can prove very useful in many simple devices, such as: delay switches, timers, waveform generators, low-frequency oscillators, relay drive circuits, indicator systems, short- and open-circuit detectors, delay systems and even simple toys.

Acknowledgment

The author expresses his appreciation to the Management of Hivac Ltd and, in particular, to Mr. F. T. Cotton, Engineer-in-Chief, for permission to publish this article.

A TRANSISTOR MULTIVIBRATOR

By B. Rakovich*, Ph.D.

An emitter-coupled free-running multivibrator is described. The durations of quasi-stable states are controlled by the charging and discharging of one timing capacitor. This circuit provides a suitable means of generating symmetrical and unsymmetrical rectangular waveforms with short transitions from one stable state to another. Another useful feature is that this circuit can generate rectangular pulses of fairly good shape at very low frequencies.

(Voir page 336 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 342)

IN conventional types of transistor multivibrators, as well as in multivibrators with thermionic valves, the main difficulty in obtaining satisfactorily shaped rectangular waveforms results from the influence of the cross-coupling capacitors. The integrating effect of these lengthens the rise- and fall-times of the waveforms at the collectors of the transistors. This effect is more pronounced when the period of the oscillations is long due to large values of the cross-coupling capacitors.

There are several methods for the reduction of the integrating effect of the cross-coupling capacitor[1,2,3,4]. A very efficient one consists in connecting the cross-coupling capacitor not directly to the collector, but through a common collector stage[3]. This method is well known and has been used for a considerable time with thermionic valve multivibrators. Another possibility consists in using combined npn and pnp transistors in series connexions in both branches of the multivibrator circuit[4]. However, in both cases the improvement in waveform can be achieved only at the expense of greater complexity of the circuit.

It is interesting to note that there are only a few references on emitter-coupled multivibrators in the existing literature[5,6]. In these arrangements, however, the signal at the collector of one transistor is not directly involved in the regenerative loop, so that no integrating effect is present at that collector. Hence, this collector makes an ideal point from which to obtain an output voltage.

An emitter-coupled free-running multivibrator, which does not seem to have been described yet, will be dealt with in following sections. At one collector symmetrical or unsymmetrical rectangular waveforms are produced having short rise- and fall-times. At the collector of the other transistor the waveform is not rectangular and therefore this circuit can be used only in those applications in which rectangular pulses of one polarity only are required.

Description of the Circuit

The emitter-coupled multivibrator to be described is shown in Fig. 1. When transistor VT_1 conducts, VT_2 is cut-off, and vice versa. In principle, the durations of both quasi-stable states depend on the magnitudes of the time-constants $C_{b1}R_{b1}$ and $C_{b2}R_{b2}$, as well as of the other circuit parameters. But, if the circuit is designed so that the transistors do not saturate when conducting, the time-constant $C_{b2}R_{b2}$ should be much greater than the duration of the stable state in which transistor VT_2 is on, $C_{b2}R_{b2} \gg T_2$. Otherwise, a noticeable distortion in the flat tops of rectangular output pulses will result. In that case the durations of the quasi-stable states are controlled by charging and discharging of the timing capacitor C_{b1} in the base circuit of VT_1.

When VT_1 conducts, its base current charges C_{b1}. In the second quasi-stable state, when VT_1 is cut-off and VT_2 conducts, C_{b1} discharges through the resistor R_{b1}. Under the condition that VT_1 does not saturate when conducting, the wave shapes at different points of the circuit are as shown in Fig. 2.

Charging of the Capacitor C_{b1}

Neglecting the voltage drop between emitter and base leads of the conducting transistor VT_1, the equivalent circuit for computing the charging period of C_{b1} takes the simplified form shown in Fig. 3. To determine the currents i_{e1}, i_1 and i_2 the following equations can be written:

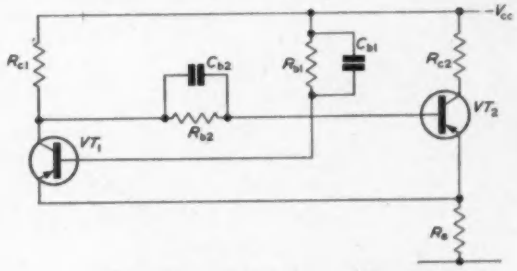


Fig. 1. The circuit of the multivibrator

$$V_{cc} - R_e i_{e1} - R_{b1} i_1 = 0 \quad \ldots\ldots\ldots\ldots \quad (1)$$

$$i_2 / C_{b1} = R_{b1}\,(di_1/dt) \quad \ldots\ldots\ldots\ldots \quad (2)$$

$$i_2 = i_{e1}\,(1 - \alpha) - I_{co1} - i_1 \quad \ldots\ldots\ldots \quad (3)$$

Eliminating i_1 and i_2:

$$di_{e1}/dt + \frac{R_{b1}(1 - \alpha) + R_e}{C_{b1}R_{b1}R_e}\, i_{e1} - \frac{V_{cc} + R_{b1}I_{co1}}{C_{b1}R_{b1}R_e} = 0 \quad \ldots\ldots \quad (4)$$

The solution of this equation is:

$$i_{e1} = \frac{V_{cc} + R_{b1}I_{co1}}{R_{b1}(1 - \alpha) + R_e} + K \exp(-t/\tau_1) \quad \ldots\ldots \quad (5)$$

where $\tau_1 = \dfrac{C_{b1}R_{b1}R_e}{R_{b1}(1 - \alpha) + R_e}$ = the time-constant of the charging circuit of the capacitor C_{b1} and K is an integrating constant.

The constant K can be determined from the initial condition:

$$(i_e)_{t=0} = V'/R_e = i_{e2}$$

where i_{e2} is the emitter current of VT_2 when this transistor is on.

Therefore:

$$K = (V'/R_e) - \frac{V_{cc} + R_{b1}I_{co1}}{R_{b1}(1 - \alpha) + R_e} \quad \ldots\ldots\ldots \quad (6)$$

and:

$$i_{e1} = \frac{V_{cc} + R_{b1}I_{co1}}{R_{b1}(1-\alpha) + R_e} + \left[i_{e2} - \frac{V_{cc} + R_{b1}I_{co1}}{R_{b1}(1 - \alpha) + R_e} \right] \exp(-t/\tau_1) \quad \ldots\ldots\ldots\ldots \quad (7)$$

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The collector voltage of VT_1, when this transistor conducts, is equal to:

$$v_{c1} = -V_{cc} + \alpha R_{c1}\frac{V_{cc} + R_{b1}I_{co1}}{R_{b1}(1-\alpha) + R_e} + \alpha R_{c1}\left[i_{e2} - \frac{V_{cc} + R_{b1}I_{co1}}{R_{b1}(1-\alpha) + R_e}\right]\exp(-t/\tau_1) \quad \ldots\ldots\ldots\ldots (8)$$

The voltage at the base of VT_2 is:

$$v_{b2} = -V_{cc} + \alpha R_{c1}i_{e1} + R_{b2}(i_{b2} - I_{co2}) \quad \ldots\ldots (9)$$

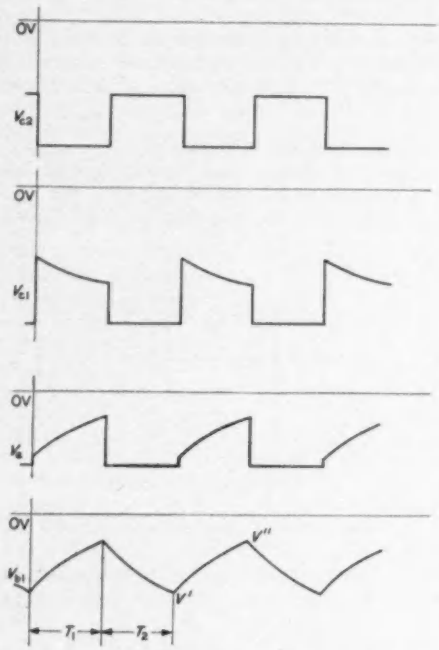


Fig. 2. The collector, base and emitter waveforms

This relation is valid under the assumption that the time-constant in the base circuit of VT_2 is much greater than the duration of the stable state in which VT_1 conducts, $C_{b2}R_{b2} \gg T_1$. In the above equation i_{b2} is the base current of VT_2 when this transistor is on. This quasi-stable state, i.e. the charging period of the capacitor C_{b1} will terminate at the instant when the base voltage equals the common emitter voltage:

$$-V_{cc} + \alpha R_{c1}i_{e1} + R_{b2}(i_{b2} - I_{co2}) = -R_e i_{e1} \quad \ldots\ldots\ldots\ldots (10)$$

Finally, from equations (7) to (10):

$$T_1 = \tau_1 \log \frac{(R_e + \alpha R_{c1})\left[i_{e2} - \dfrac{V_{cc} + R_{b1}I_{co1}}{R_{b1}(1-\alpha) + R_e}\right]}{V_{cc} - R_{b2}(i_{b2} - I_{co2}) - \dfrac{(V_{cc} + R_{b1}I_{co1})(R_e + \alpha R_{c1})}{R_{b1}(1-\alpha) + R_e}} \quad \ldots\ldots\ldots\ldots (11)$$

The numerator of the expression on the right-hand side is positive. Consequently, a necessary condition for oscillation is as follows:

$$i_{e2} > \frac{V_{cc} + R_{b1}I_{co1}}{R_{b1}(1-\alpha) + R_e} \quad \ldots\ldots\ldots\ldots (12)$$

Stability conditions imply that the left-hand side of this inequality should be much greater than the right-hand side.

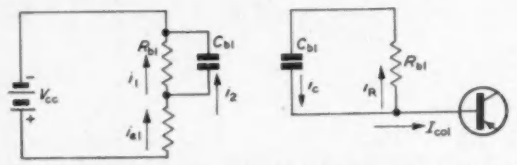


Fig. 3 (left) Equivalent circuit for computing the charging period of the capacitor C_{b1}

Fig. 4 (right) Equivalent circuit for computing the discharging period of the capacitor C_{b1}

This imposes the limitation for the smallest value of the resistor R_{b1}.

DISCHARGING OF THE CAPACITOR C_{b1}

The capacitor C_{b1} discharges during the second quasi-stable state in which VT_2 conducts while VT_1 is cut off, because of the inverse polarization of its emitter-base junction. The equivalent circuit for computing the duration of the discharging period of C_{b1} is shown in Fig. 4. This period is not only controlled by the discharge of C_{b1} through R_{b1}, but also by the base current which flows when VT_1 is cut off. The current i_R can be determined by the equations:

$$\frac{di_R}{i_R + I_{co1}} = -C_{b1}R_{b1}\,dt \quad \ldots\ldots\ldots\ldots (13)$$

$$i_R = K\exp(-t/\tau_2) - I_{co1} \quad \ldots\ldots\ldots\ldots (14)$$

where $\tau_2 = C_{b1}R_{b1}$ is the time-constant of the discharging circuit and K is the integrating constant. The constant K depends on the initial condition of C_{b1}:

$$K = \frac{V_{cc} - V''}{R_{b1}} + I_{co1} \quad \ldots\ldots\ldots\ldots (15)$$

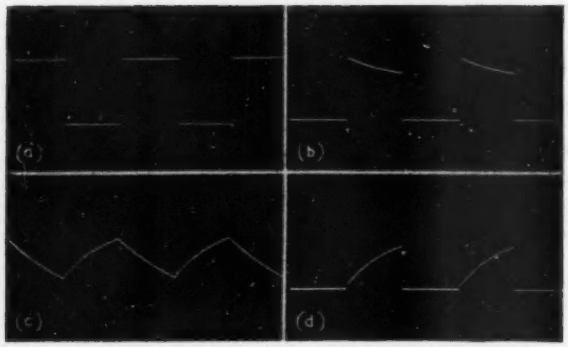
where V'' is the base voltage of VT_1 at the end of the charging period of the capacitor C_{b1}:

$$V'' = (v_{b1})_{t=T_1} \simeq v_e = -R_e(i_{e1})_{t=T_1} = -\frac{R_e(V_{cc} + R_{b1}I_{co1})}{R_{b1}(1-\alpha) + R_e} - R_e\left[i_{e2} - \frac{V_{cc} + R_{b1}I_{co1}}{R_{b1}(1-\alpha) + R_e}\right]\exp(-T_1/\tau_1) \quad \ldots\ldots\ldots\ldots (16)$$

Therefore, the base voltage of VT_1 during this quasi-stable state is:

$$v_{b1} = -V_{cc} + R_{b1}i_R = -V_{cc} + R_{b1}\left(\frac{V_{cc} - V''}{R_{b1}} + I_{co1}\right)\exp(-t/\tau_2) - R_{b1}I_{co1} \quad \ldots. (17)$$

Fig. 5. Multivibrator output waveforms



or:

$$v_{b1} = -V_{cc} + (V_{cc} - V'' + R_{b1}I_{co1}) \exp(-t/\tau_2) - R_{b1}I_{co1} \quad \ldots\ldots\ldots\ldots (18)$$

The discharge of C_{b1} terminates at the instant when the base voltage of VT_1 equals the common emitter voltage. Then a new cumulative process starts bringing the circuit back to the first quasi-stable state:

$$v_{b1} = -V_{cc} + (V_{cc} - V'' + R_{b1}I_{co1}) \exp(-T_2/\tau_2) - R_{b1}I_{co1} = -R_e i_{e2} \quad \ldots\ldots\ldots\ldots (19)$$

Consequently, it follows that:

$$T_2 = \tau_2 \log \frac{V_{cc} - V'' + R_{b1}I_{co1}}{V_{cc} - R_e i_{e2} + R_{b1}I_{co1}} \quad \ldots\ldots\ldots (20)$$

Experimental Results

The waveforms at different points of the multivibrator are shown in Fig. 5. The experiment was carried out with pnp transistors type 2N414. The other circuit parameters were as follows: $R_e = 2\text{k}\Omega$, $R_{c1} = R_{c2} = 820\Omega$, $R_{b1} = 82\text{k}\Omega$, $R_{b2} = 20\text{k}\Omega$, $C_{b1} = 0{\cdot}01\mu\text{F}$, $C_{b2} = 2\mu\text{F}$, $V_{cc} = -9\text{V}$. Frequency of oscillations: 1kc/s. Rise- and fall-times of the rectangular waveform at the collector of VT_1: about $0{\cdot}5\mu$sec.

The ratio of the durations of the quasi-stable states was varied over a large range by changing the resistor R_{b1}.

By changing the value of the capacitor C_{b1} the period of oscillations can be varied while keeping the ratio T_2/T_1 unchanged. This is in accordance with equations (11) and (20) showing that T_1 and T_2 are directly proportional with C_{b1}.

Another characteristic of this multivibrator, which is of importance for some applications, is that the circuit is suitable for generation of symmetrical and unsymmetrical waveforms of fairly good rectangular shapes at very low frequencies. With $C_{b1} = 300\mu\text{F}$, $C_{b2} = 3\,000\mu\text{F}$ and with other circuit parameters unchanged a period of 30sec was obtained.

Conclusion

Emitter-coupled multivibrators provide very suitable means of generating rectangular waveforms. In that sense they have distinct advantages over the more conventional multivibrator circuits.

In the circuit described in this article, the duration of the quasi-stable states are determined by charging and discharging of one timing capacitor. This circuit can generate symmetrical and unsymmetrical rectangular pulses with rise- and fall-times less than 1μsec. In unsymmetrical operation a high ratio of the durations of quasi-stable states can be achieved.

Finally, another important feature of this circuit is that it can generate rectangular waveforms at very low frequencies. During the experiments a period of oscillations of 30sec was obtained, but there is no reason to believe that an even longer duration could not be obtained.

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Simple Display of Television Receiver Response*

There are several methods known by means of which a television receiver may be made to display its own response curve (e.g. British Patent No. 633 081) but a much simpler apparatus may be used than previously has been described.

The response curve is simply a graph representing the output voltage of the receiver at a test frequency as a function of the test frequency.

As in previous methods, the frame scan of the receiver may be used as one co-ordinate of the display if the test oscillator is frequency modulated with a sawtooth waveform at frame frequency.

In order to develop the other co-ordinate (i.e. the response of the equipment at the test frequency), it not being convenient to modulate the amplitude of the line scanning oscillator, it is necessary to produce a time delay dependent on the output voltage of the receiver and to change the intensity of the cathode-ray tube beam at this time after the beginning of the line scanning stroke.

The apparatus required, in addition to the frequency modulated oscillator, consists of a short grid base, high slope pentode to the grid of which is fed both the receiver output signal and the line scanning voltage as shown in Fig. 1. The valve is arranged to be either conducting or non-conducting. The time of transition between these two states being dependent, therefore, upon the amplitude of the response signal. The output from the anode of this valve is fed to the cathode-ray tube to modulate the beam.

In practice, a separate valve need not be used if the vision amplifier valve is of a suitable type, in which case

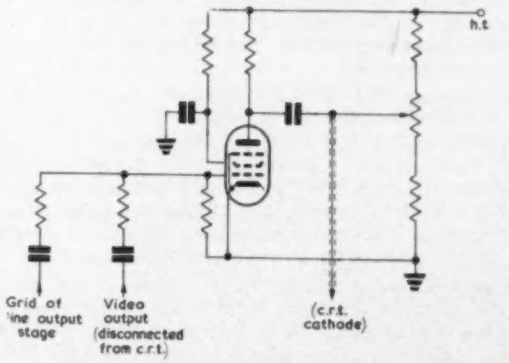


Fig. 1. The method of modulating the cathode-ray tube

a means of feeding the line scanning voltage to its grid need be employed only.

The response curve will be represented on the screen as the boundary between the light and dark areas.

* *A communication from E.M.I. Ltd.*

The CANTAT Submarine Cable System

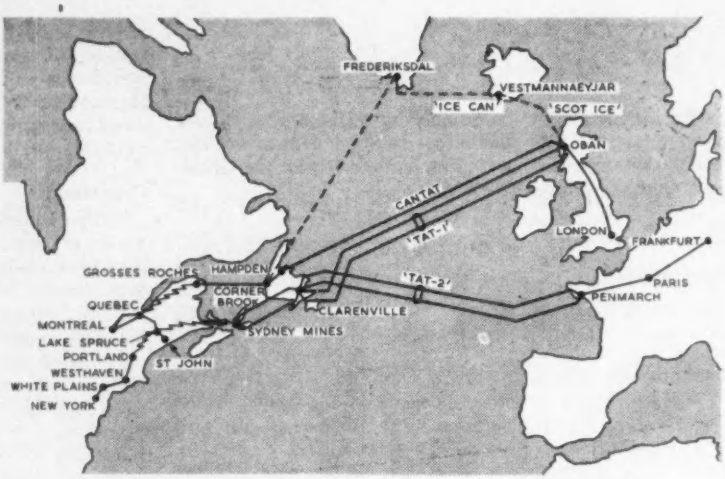


Fig. 1. The routes taken by the cables including those planned to Iceland

AT the beginning of last month H.M.T.S. *Monarch* left Oban, Scotland to lay a submarine telephone cable to Canada. This cable is to form the first section of one of the most ambitious communication systems ever proposed, namely the Round-the-World Commonwealth Submarine Telephone Cable and will be known as the Anglo-Canadian Transatlantic Telephone or CANTAT. It is expected to be in operation by the autumn of this year.

It will be recalled that the first transatlantic telephone cable[1] known as TAT 1, linking the United Kingdom with Canada and the United States was completed in September 1956. This was a joint undertaking by the British Post Office, the Canadian Overseas Telecommunication Corporation and the American Telephone and Telegraph Company. The deep sea section was laid between Oban, Scotland, and Clarenville, Newfoundland, and consisted of two separate submarine cables some 1 950 miles in length for the two directions of transmission with 51 repeaters. It provided 29 telephone circuits between London and New York, six similar circuits between London-New York and London-Montreal for telegraph and other reduced bandwidth purposes.

From Clarenville to Sydney Mines (Nova Scotia) was a single cable some 270 miles in length providing 60 circuits, and incorporating 16 two way repeaters. Of these 60 circuits, 36 were for use with the transatlantic system, and the remaining 24 circuits were intended for local use between Newfoundland and the Canadian mainland.

Connexion from Sydney Mines to the mainland was made by a microwave link terminating near St. John, where it connected with the main Canadian and American telephone networks.

A second transatlantic telephone cable[2] known as TAT 2 was completed in September 1959. It was in all respects a replica of TAT 1 and was laid between Clarenville, Newfoundland and Penmarch on the French Atlantic Coast. It was a joint undertaking between the American Telephone and Telegraph Company and the French and German Telephone administrations and it provided 36 circuits between New York and Paris and Frankfurt.

Following earlier discussions in London it was decided at a Conference at Ottawa in 1957 that a new submarine cable system providing 60 circuits should be laid between Canada and the United Kingdom under the joint ownership of Cable and Wireless Ltd and the Canadian Overseas Telecommunication Corporation. This led to a further proposal at the Commonwealth Telecommunications Conference in 1958 that a Round-the-World Commonwealth Telephone Cable system should be planned and that the Anglo-Canadian cable CANTAT should form the first link. The total length of the cable system would be some 32 000 miles and the cost about £88M, half of which would be borne jointly by the Post Office and Cable and Wireless Ltd. The remaining cost would be borne by the administrations of the Commonwealth countries linked by the cable.

The second stage of the Commonwealth Telephone Cable Scheme is to consist of a similar cable across the Pacific Ocean, linking Canada with Australia and New Zealand, a distance of about 8 000 nautical miles. Orders for cables and repeaters for this COMPAC section[3] have already been placed and the scheme is expected to be completed in 1964. From Vancouver the cable will be laid to Honolulu, Fanning Island, Suva, Auckland, New Zealand and thence to Sydney, Australia.

Details of the return section from Australia to the United Kingdom have not yet been settled but it is probable that the route will be from Perth, Western Australia to the Cocos Islands, Penang, Colombo, Bombay (with a spur to Karachi), Seychelles, Mombasa and Durban where it will connect with the internal network of the Union of South Africa. The final leg will be from Cape Town, St. Helena, Ascension, Bathurst, Gibraltar and finally to the United Kingdom.

The CANTAT Cable

The route of the CANTAT Cable is shown in Fig. 1.

The main deep sea crossing will be from Oban, Scotland to Hampden at the head of Whitebay, Newfoundland. This section, some 2 100 nautical miles in length, will, except for the shore ends, consist of the new lightweight cable designed by the Post Office and manufactured by Submarine Cables Ltd.

On this section 90 submerged repeaters will be required together with seven equalizer sections. The repeaters are of the British rigid design used originally in the Clarenville-Sydney Mines section of the first transatlantic telephone cable (TAT 1) and manufactured by Standard Telephones and Cables Ltd.

From Hampden the route will continue across Newfoundland for a distance of about 70 nautical miles to Cornerbrook with a screened submarine cable and four repeaters, and from Cornerbrook to Grosses Roches on the Canadian mainland, a distance of about 400 nautical miles a further lightweight submarine cable with 20 re-

peaters will be laid by the new Post Office Cable Ship *Alert*.

The cable and repeaters on this section have been manufactured by Submarine Cables Ltd. and have a capacity of 120 circuits. Sixty of these channels will be used for the CANTAT route, and the remainder for use between Newfoundland and the Canadian mainland.

At Grosses Roches, a microwave link will connect the CANTAT system into the Canadian telephone network.

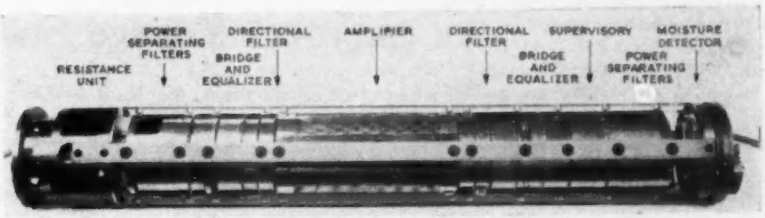


Fig. 3. The rigid two-way repeater

Cable Construction

The deep sea section between Oban and Hampden will consist of the new unarmoured lightweight coaxial cable designed by the Post Office.

The strength member, which is essential to withstand the tension set up in laying and recovery operations, consists of a central core of a high-tensile non-twisting steel-wire strand around which is wrapped the inner conductor of coaxial cable proper and this is formed from a copper tape tightly box-seamed in a longitudinal direction on to the steel strand.

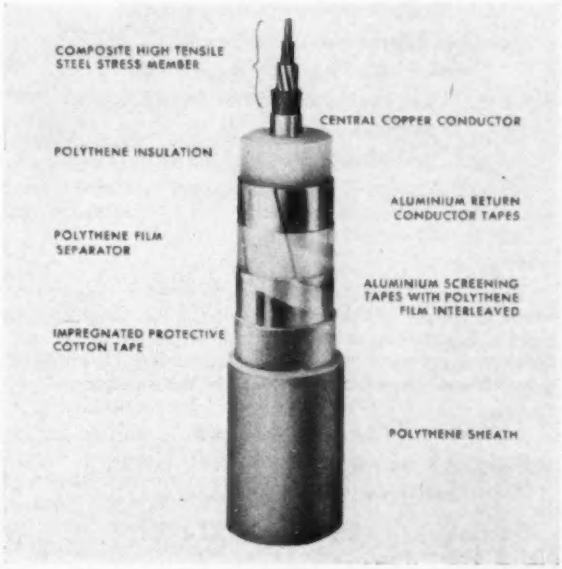
Polythene insulation is then extruded on to the conductor after which the outer coaxial conductor of aluminium tape is wound. A thin film of polythene is wound over this and a further aluminium tape interleaved with polythene film is applied to form a screen.

The cable is completed with a layer of impregnated cotton tape and an outer sheath of polythene about 1/10in thick. The overall diameter of the cable is about 1¼in. The cable make-up is shown in Fig. 2.

Repeater Equipment

The new lightweight cable has an attenuation of about two-thirds of the original TAT cables, so that fewer repeaters will be required. Unlike the TAT systems where cables and unidirectional repeaters were used for each direction, a single cable will be used for both directions.

Fig. 2. The new lightweight coaxial cable



The repeaters for the CANTAT cable are similar in mechanical design to the Post Office type repeaters laid between Clarenville and Sydney Mines on the TAT 1 and TAT 2 systems (see Fig. 3).

Considerable improvements have however been made in the electrical performance of the new repeaters. The major features being:—

(1) A new and improved long life valve is being em-

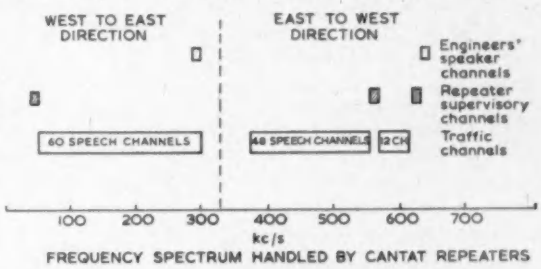


Fig. 4. The frequency allocation

ployed which results in a reduced supply voltage to each repeater.

(2) A new monitoring network is incorporated by means of which possible faults in the repeater can be located. The network provides facilities for the first time for the location of a wideband noise fault.

(3) The insulation of the unit has been increased so that the repeater can now operate continuously at 5kV to earth.

(4) Means have been included to prevent possible high voltage surges at the repeater terminals from damaging the repeater components.

The amplifier unit consists of two three-valve amplifiers in parallel with a common negative feedback network. A fault in either amplifier circuit will not significantly affect the performance of the repeater as a whole.

The power supply equipment at the shore end of the cable supplies a direct current, stabilized to within one per cent, to the central core of the cable for filament and anode supplies of the repeaters which are series connected and have power separating filters.

In normal operation each terminal equipment supplies half the total voltage required of about 10kV so that the voltage above earth of any repeater varies from 5kV at the shore ends to zero at the midpoint of the cable.

The frequency band of the CANTAT system extends from 50kc/s to just over 600kc/s. The band from 60 to 300kc/s is to be used for traffic in the direction from Cornerbrook to Oban and the band 360-608kc/s in the reverse direction.

The allocation of the channels is shown in Fig. 4.

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An Improved Voltage Stabilizer

By A. K. Chatterjee*, M.S., Ph.D., K. V. Ramanan* and B. S. Rao*

In an amplified degenerative type of voltage stabilizer, two stages of d.c. amplification are often used in the shunt control circuit to improve stabilization with respect to output voltage fluctuations. In the present article it is shown that input compensation, introduced in the suppressor grid of the second d.c. amplifier valve results in very high stabilization with respect to input voltage fluctuations. Considerations in the design and the improvements in performance of the input compensated stabilizer are discussed.

(Voir page 336 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 342)

THE degenerative type of voltage stabilizer is capable of giving very high stabilization for input voltage fluctuations provided it is possible to have optimum input compensation. The screen of the shunt control valve has been employed in the past for providing input compensation[1]; but the performance has been far from satisfactory because of the critical adjustments and limitations inherent in this type of compensating circuit[2].

It has been observed that as the suppressor grid bias of a pentode approaches the cut-off value, it has effective control over the anode current. This is due to the formation of a virtual cathode before the suppressor grid which then acts like the control grid of a triode[3]. The above

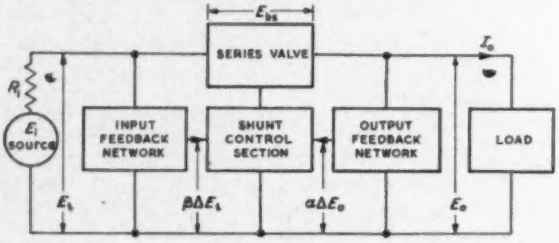

Fig. 1. The stabilizer employing both input and output compensations

phenomenon has been utilized to provide input compensation for mains fluctuation in degenerative types of stabilizers. It has been established[4] that in the case of a degenerative type of stabilizer employing a single stage of d.c. amplification in the shunt control section, the suppressor input compensated type has superior performance over the screen-input compensated circuit in all respects. The arrangement employing the suppressor grid enables the screen to be fed from a stabilized supply which is desirable to avoid large fluctuations in the gain of the control valve. There is usually a tendency for over compensation in the screen input compensated circuit and the adjustment of the screen grid potential to secure optimum compensation, is extremely critical and generally differs from that required for the proper quiescent screen voltage. Even a slight deviation from the optimum adjustment is found to affect the stabilization adversely. These inherent disadvantages have been completely eliminated in the suppressor grid controlled stabilizer. In the present article the above principle has been extended to a degenerative stabilizer employing two stages of d.c. amplification.

The method of introducing the input compensation and the effect of the feedback factor have been discussed. The improvement in the performance of the stabilizer has been indicated on the basis of experimental results.

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Theoretical Analysis

Fig. 1 shows the block schematic diagram of a stabilizer employing both input and output compensation.

$$E_i = I_oR_i + E_{bs} + E_o \quad \ldots\ldots\ldots\ldots \quad (1)$$

where E_i = Source voltage,

E_o = Output voltage,

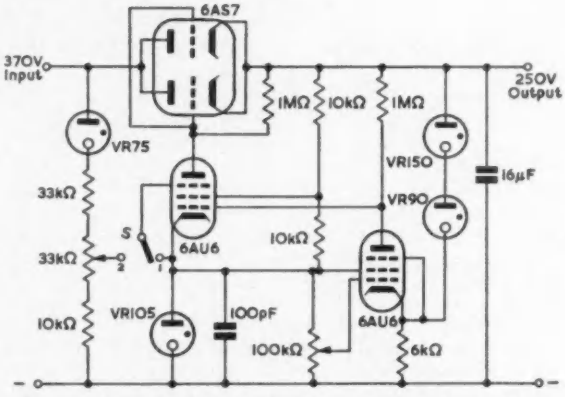


Fig. 2. Suppressor-grid controlled voltage stabilizer for 250V output

R_i = Source resistance,

E_{bs} = Anode-cathode voltage of the series tube,

I_o = Load current.

Taking the differentials of equation (1):

$$\Delta E_i = \Delta I_o(R_i + r_{as}) - \mu_s e_{gs} + \Delta E_o \quad \ldots\ldots\ldots \quad (2)$$

where r_{as} = a.c. anode resistance of the series valve

μ_s = amplification factor of the series valve

and e_{gs} = grid-cathode signal of the series valve.

ΔE_i and ΔE_o are incremental changes in source voltage and output voltage respectively. ΔI_o is an incremental change in load current.

Now:

$$e_{gs} = -A_1\alpha\,\Delta E_o - A_2\beta\,\Delta E_i \quad \ldots\ldots\ldots \quad (3)$$

where A_1 refers to the total gain of the d.c. amplifiers for signals due to output changes and A_2 refers to the gain between suppressor and anode of the second d.c. amplifier. α and β are the output and input feedback factors.

Also:

$$\Delta E_i = \Delta E_i - \Delta I_oR_i \quad \ldots\ldots\ldots\ldots \quad (4)$$

Substituting equations (3) and (4) in (2) yields:

$$\text{Stabilization factor } s = [\Delta E_i/\Delta E_o]_{\Delta I_o = 0}$$

$$= \frac{1 + \mu_s A_1\alpha}{1 - \mu_s A_2/\beta} \quad \ldots\ldots\ldots\ldots \quad (5)$$

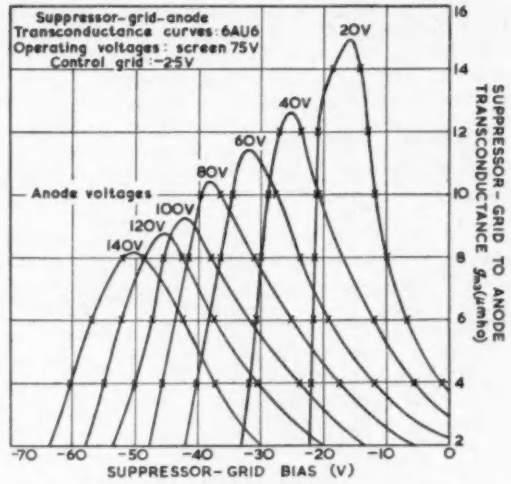


Fig. 3. Suppressor-grid-anode transconductance for 6AU6

and output impedance $R_o = -[\Delta E_o/\Delta I_o]_{\Delta E_1 = 0}$

$$= \frac{r_{as} + R_l(1 - \mu_s A_2 \beta)}{1 + \mu_s A_1 \alpha} \quad \ldots\ldots\ldots (6)$$

From equation (5), the condition for infinite stabilization is given by:

$$\mu_s A_2 \beta = 1 \quad \ldots\ldots\ldots\ldots\ldots (7)$$

The gain A_2 may be expressed as:

$$A_2 = +g_{m3} \frac{r_a R_L}{r_a + R_L} \quad \ldots\ldots\ldots\ldots (8)$$

where g_{m3} = suppressor-grid-anode transconductance

r_a = anode resistance

and R_L = load resistance.

So, for given values of r_a and R_L, there exists an optimum value of g_{m3} which will yield infinite stabilization. Furthermore, equation (6) shows that the output impedance:

$$R_o = \frac{r_{as} + R_l}{1 + \mu_s A_1 \alpha} \quad \ldots\ldots (9)$$

when there is no input compensation. When there is optimum input compensation yielding infinite stabilization,

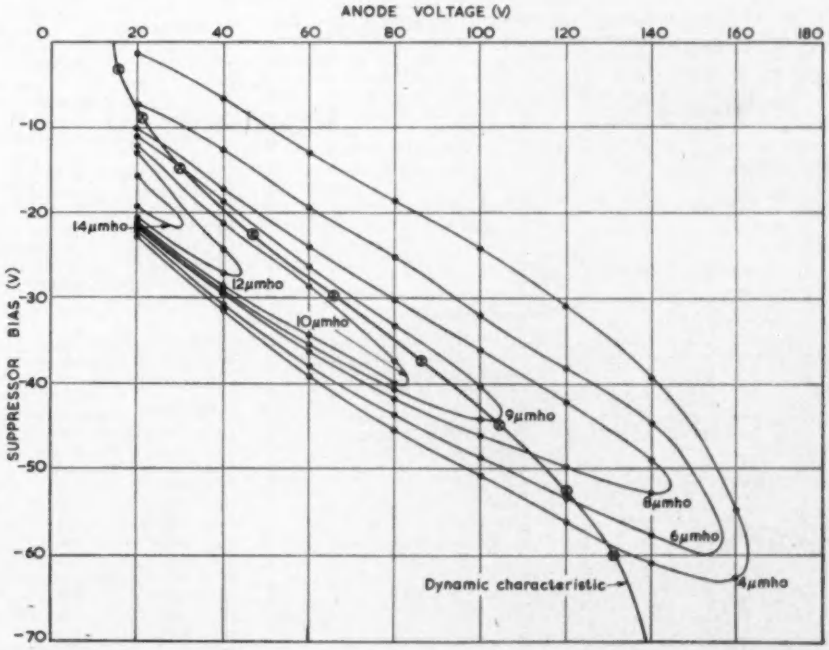
$$R_o = \frac{r_{as}}{1 + \mu_s A_1 \alpha} \quad \ldots\ldots (10)$$

which is normally less than that given by equation (9).

Fixing of the Operating Point and Prediction of Performance

The experimental regulator circuit is shown in Fig. 2. The 6AS7 twin triode is used as the series valve since its low anode resistance of 280Ω is helpful to obtain a low output impedance as can be seen from equation (6). Type 6AU6 sharp cut-off pentodes are used for d.c. amplification. The load resistors of 1MΩ yield maximum gain. The output feedback factor α is made nearly equal to unity by employing a VR150 and a VR90 in series with the cathode resistor of 6kΩ, since the total fluctuation of the output is almost confined across the cathode resistor. The nominal input is 370V, the limits of input variation being 300 to 440V. By adjusting the tapping point of the grid bias of the first d.c. amplifier on the 100kΩ potentiometer, the required output of 250V can be obtained. The control grid bias needed for the second d.c. amplifier for the nominal operating point was found to be −2·8V and the screen voltage was 75V. In order to maintain the series valve bias at the same value when the suppressor is made negative, the control grid bias has to be made less negative and −2·5V has been found to be an optimum value. To decide upon suitable operating bias for the suppressor grid, the suppressor grid-anode transconductance g_{m3} for a 6AU6 was measured for various anode voltages and suppressor grid voltages at a control grid bias of −2·5V and a screen potential of 75V. A plot of this parameter is given in Fig. 3. Fig. 4 gives the constant g_{m3} contours derived from Fig. 3 and plotted on the suppressor bias-anode voltage plane. A dynamic characteristic relating the suppressor and anode voltages was obtained experimentally under the above operating conditions and has been plotted on the contours of Fig. 3. A suppressor bias of −30V is found to yield the nominal operating point and the required series valve bias. The value of g_{m3} at this point on the dynamic characteristic is found to be 9·5 micromhos. This operating point is satisfactory as it is midway between the points at which the g_{m3} value deviates far from that at the nominal operating point. Since there is an input variation of 70V on either side of the nominal operating point and since the dynamic characteristic crosses the 8 micromhos contour at bias values of −12 and −48V (i.e. equal swing of suppressor bias from the nominal operating point for equal change in the value

Fig. 4. Constant g_{m3} contours of suppressor grid for 6AU6



of transconductance of g_{m3}), the nominal operating point can be fixed at a suppressor bias of −30V.

In order to satisfy the infinite stabilization condition at the chosen operating point, the input feedback factor β has to be adjusted. In the present case, $g_{m3} = 9{\cdot}5$ micromhos and r_a as measured at the nominal operating point = 0·27MΩ. Substituting these values in equation (8) gives $A_2 = 2{\cdot}02$. Since $\mu_2 = 2$ for the 6AS7, $\beta = 1/4{\cdot}04$ from equation (7). This value of β will satisfy the condition of infinite stabilization at the nominal operating point.

In the circuit of Fig. 2, the suppressor has to be at a potential of 75V with respect to ground in order to have a bias of −30V. A simple resistive potential divider will yield a β of $75/370 = 0{\cdot}203$ only, which is far less than that needed for infinite stabilization. Hence a regulator tube in conjunction with a potential divider arrangement has been used. Switch S at position 2 gives the suppressor input compensation. In position 1, the circuit is the normal output compensated type. If a VR75 is used as shown, $\beta = 75/(370-75) = 0{\cdot}254$. This is quite satisfactory.

To predict the performance of the set up, r_a has been measured at several points on the dynamic characteristic and A_2 has been calculated therefrom. The results are given in Table 1.

For input variations from 300 to 440V, the suppressor bias will vary from −47·6 to −12·4V. It can be seen from Table 1 that throughout this range, the value of $(1 - \mu_2 A_2 \beta)$ is less than 1 and that infinite stabilization occurs in the middle range with a slight tendency for over compensation. Experimentally it has been observed that there is no noticeable over compensation. The discrepancy is due to experimental errors in the values of g_{m3} and r_a. Thus the chosen operation must yield high stabilization over the whole range of operation.

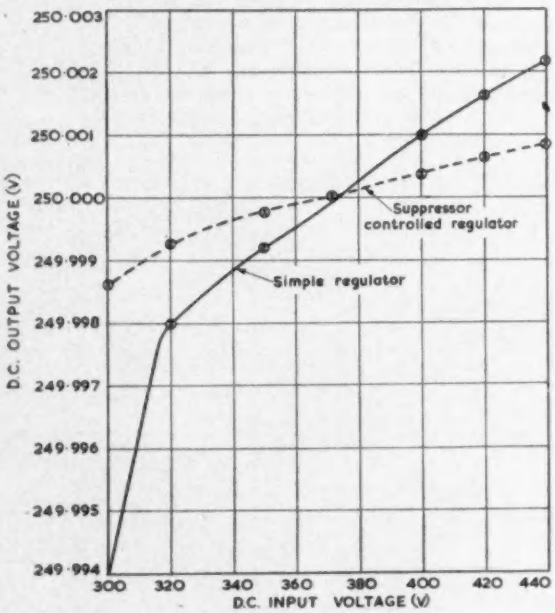
Experimental Data and Theoretical Verification

Stabilization Factor S

To compare the relative performances of the simple and suppressor controlled stabilizers, the ripple outputs for a constant input ripple have been measured at various d.c. input voltages and the results are given in Table 2.

The increase in stabilization at higher input voltages, i.e. 370 to 420V in both the cases is because the control grid and suppressor grid become less negative with increase in the input voltage which results in an increase of the gain.

Fig. 5. Operation characteristic of the stabilizer



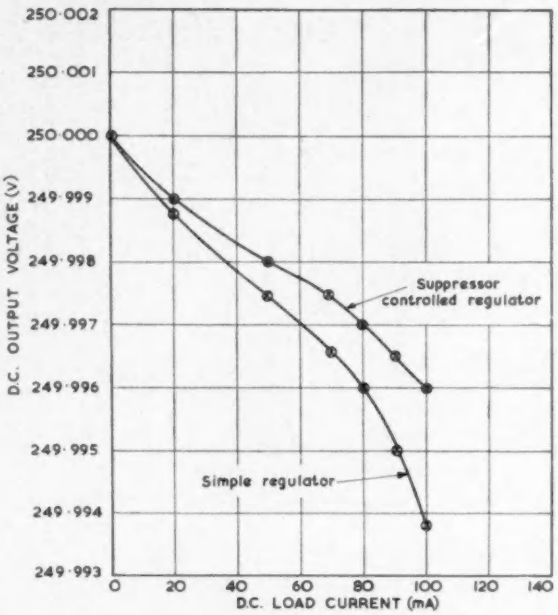


Fig. 6. Operational characteristic of the stabilizer

Operation Characteristic of the Stabilizer

The d.c. output voltage has been measured under no-load

TABLE 1

SUPPRESSOR BIAS (V)	SUPPRESSOR-ANODE TRANS-CONDUCTANCE g_{m3} (MICROMHOS)	ANODE RESISTANCE r_a (kΩ)	SUPPRESSOR-ANODE GAIN A_2
− 9·0	7·0	270	1·5
−15·0	9·0	240	1·74
−22·5	9·5	250	1·9
−30·0	9·5	270	2·02
−37·5	9·5	280	2·08
−45·0	8·5	290	1·91
−52·5	6·0	380	1·65
−60·0	4·0	420	1·18

TABLE 2

Input Ripple Voltage = 10V. No load condition

INPUT D.C. VOLTAGE	SIMPLE REGULATOR		SUPPRESSOR-CONTROLLED REGULATOR	
	RIPPLE OUTPUT (mV)	STABILIZATION S	RIPPLE OUTPUT (mV)	STABILIZATION S
300	3·6	2 780	1·2	8 350
320	1·4	7 150	0·96	10 400
350	1·0	10 000	0·78	12 800
370	1·0	10 000	0·50	20 000
400	0·98	10 200	0·44	22 700
420	0·97	10 300	0·32	31 300
440	1·0	10 000	0·40	25 000
450	1·1	9 100	0·94	10 650

condition for various input voltages and the results are plotted in Fig. 5. The changes in output voltage for load current variations in the range 0 to 100mA have been measured at a nominal input of 370V and plotted in Fig. 6. These experimental results confirm the theoretical predictions regarding stabilization and output impedance. The experimentally measured values of output impedance are 0·06Ω for the case of no input compensation and 0·04Ω for the suppressor input compensated set up.

Conclusion

The experimental observations supported by theoretical prediction confirm the advantages anticipated from the application of input compensation to the suppressor grid in the degenerative type of voltage stabilizer. The method of compensation described in this article can be quite easily set up and can be added to any existing regulator to improve its performance. The addition of this compensating unit has the advantage that it can be put into commission without affecting appreciably the other operating conditions of the circuit. By changing the voltage regulator tube or by completely eliminating it, any required input feedback factor can be obtained. This flexibility of altering β alone, without changing the operating conditions, makes it feasible to have any amount of compensation. It has been verified experimentally in the present set-up, that the use of a VR105 or VR150 instead of the VR75 for the same suppressor bias of -30V, results in over compensation which demonstrates the effect of increased β. Thus the method of applying input compensation using the suppressor grid is found to have far-reaching applications.

Acknowledgment

The authors gratefully acknowledge the facilities provided by the Principal, Birla Engineering College, for carrying out the investigation.

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A Precise Length Measuring System

Length measuring systems can be divided broadly into two types, the digital or incremental, and the analogue or proportional.

A scale calibrated in discrete steps, a pile of slip gauges, or a diffraction grating, are of the incremental type; while proportional systems are represented by the screw thread and nut, or the wound helix or similar patterns. The advantage of the incremental system is the high accuracy of successive steps, but each step must be counted and stored, and the loss of one is a continuous error. The analogue method has one unique indication of position, but it is difficult to manufacture the measuring elements to the very high precision required.

The system developed by Reilly Engineering Ltd is claimed to have the advantages of both systems and the disadvantages of neither. It gives an analogue representation of position using an incrementally constructed measuring element. The standard form of measuring element consists of a series of accurately made cylinders insulated from each other, threaded on to a tie-rod and cemented and clamped together with sufficient pressure to make the composite bar straighter and stiffer than the equivalent solid bar.

Other forms of construction are a series of flat electrodes mounted on an insulating base, or formed in metallizing on the surface of glass or ceramic. The length may be increased indefinitely by joining units end to end. The system also lends itself to circular measurements in which the electrodes are segments of a circle in conjunction with a rotating interpolation electrode.

If each segment of the measuring bar is connected to a precise voltage dividing transformer, the voltage between each segment is equal, and a very small pick-off electrode, close to but not touching the row of segments so that it has a capacitance to them, will increase in potential in a series of steps as it is moved along. If the pick-up electrode is made the same length as the segments, it will act as a differential capacitor and interpolate continuously between the voltage on the individual segments.

To avoid making very accurate measurement of voltage, the circuit is constructed as a bridge so that the position of the pick-up relative to the row of segments is compared with the position of a tap on a transformer.

The position of the head is indicated by adjusting the taps on the transformers until the potential of the interpolating electrode is seen to be zero by a centre zero meter. The number of taps on the transformer can be increased indefinitely by a series of cascaded decade units. This process may be continued to sub-divisions of 100 000 parts or more, and the null indicating meter calibrated to give much smaller increments. For example, if the shaft is designed to measure 10in, there may be six decades, the first having 10 steps of 1in and the last ten steps of 0·000 01in. The meter may be calibrated ±0·000 1in f.s.d. and the smallest readable movement will be about 1 per cent of full scale, or 0·000 001in which is the sensitivity of that particular model.

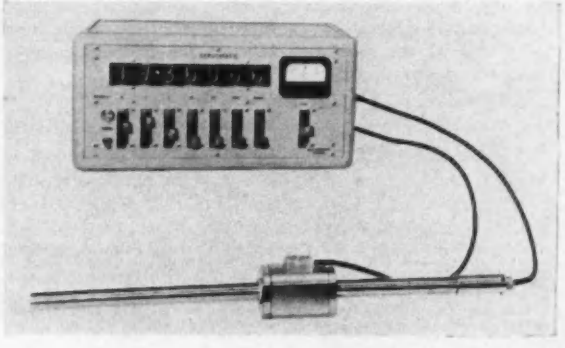
The system may be used in a number of ways. A dimension may be set on the switches and the head moved on the shaft until the meter reads zero, or the head or shaft may be moved, and the switches made to drive themselves into balance automatically, so that they continuously monitor the movement under observation. The dimension may then be displayed on large number lamps and in a remote position. Because the output of the bridge is a phase conscious system which always indicates the direction which it is necessary to move to restore balance, and has a signal proportional to the displacement, it is an ideal signal for automatic positioning systems. It will enable a device to be positioned at any desired speed and give any amount of warning as to when the balance position is approached so that slowing is achieved at the optimum time.

Because of the bridge construction, a standing signal can be introduced into the circuit which is an exact part of the carrier supply. This is set by a second set of switches and constitutes a zero offset, so that the indicated zero can be anywhere on the transducer.

Individual transducers can be calibrated so as to give a corrected reading at intervals. This is a permanent built-in feature making it possible to correct for errors in manufacture, and produce very high accuracy results. With this arrangement it is also possible to partly correct for errors in slideways to which the transducer is attached. With the more accurate applications it will always be necessary to make the final adjustment to the calibration *in situ*. Transducers are normally made from steel, but can be in any material, brass, ceramic, or Invar to suit the particular application.

A range of transducers and indicating instruments designed on the principles outlined above is manufactured by Reilly Engineering Ltd of Guildford, Surrey. They are available for measurements between 1in and 100in with accuracies from ·00003 to ·001in according to size.

A 20in transducer and seven digit display equipment



Versatile Feedback Amplifier for Computers, Laboratories and Industrial Use*

The experimental work on electronic amplifiers carried out in connexion with the design and construction of the E.R.A. network analyser has shown the convenience and economic saving that may be effected by carrying a stock of a few types of standard units.

The design of such standard units is discussed in detail. An orderly procedure for converting them to satisfy given requirements is described and illustrated by an example.

(Voir page 336 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 342)

AMPLIFIERS are present in much electronic equipment. A given type of amplifier, forming a sub-unit of a larger equipment is often mass produced at low cost. However, the diversity of requirements met in various applications is so great that no single type of amplifier has been mass produced as a separate general purpose unit. Such amplifiers as are separately available are, therefore, relatively expensive, while the number of types required to cover the most frequent needs of a development laboratory makes stocking difficult.

It is clearly impossible to attain complete versatility in any single low-cost unit. However, with the development of feedback technique, it appears quite feasible to cover the majority of requirements in a given frequency band by means of no more than two or three types of unit which could then become standard stock items. Available 'off the shelf', any such unit could be converted to suit a given application by wiring-in one or two additional components.

This article describes the design and performance of two types of 'stock' amplifiers and presents a simple method of modifying them to give the desired characteristics.

Stability and Linearity

The total output of a physical amplifier having a sine wave input must in general be represented by a Fourier series based on the input frequency. The transfer function (output divided by input) is therefore also an infinite series. The first term in this series represents the fundamental frequency component of the complex gain, the remaining terms are the conversion gains. The series may be expressed as:

$$A' = Ae^{j\theta} + DA \quad \ldots\ldots\ldots\ldots \quad (1)$$

where A' = total forward gain (infinite series).

$A'' = Ae^{j\theta}$ = complex fundamental frequency gain.

D = total distortion coefficient.

None of these quantities is constant. D depends mainly on the output level. The phase shift—or phase deviation—θ depends mainly on frequency. The modulus of the gain, A, depends on frequency and time, the time dependence being due to the time variation of the operating conditions, component values, etc.

If a fraction β of the output voltage be reversed in phase and fed back into the amplifier input, then the composite overall gain G' becomes:

$$G' = \frac{A'}{1 + \beta A'} = Ge^{j\theta} + dG \quad \ldots\ldots\ldots \quad (2)$$

The ratio of the total gains before and after the application of feedback†, $A'/G' = 1 + \beta A' = B'$, will be termed the total feedback ratio. The value of this ratio at mid-band frequency is denoted by B_0. Any small but finite deviation of gain or phase-angle represented, say, by Δ will be reduced by feedback to a new value $\delta = \Delta/B_0$.

The feedback ratio B_0 is a direct measure of improvement in performance obtainable by reducing the mid-band gain from A_0 to G_0. It is readily seen that $\delta/G_0 = \Delta/A_0$. Such quantities, termed normalized gain (or phase) deviations, are independent of feedback, thus providing useful figures of merit, or rather de-merit, for a design. For example, a modification which results in doubling the value of A_0 gives a net improvement of gain stability only if the value of Δ for a given change of operating conditions be less than doubled at the same time.

The total output of an amplifier contains also the noise and hum voltages, say V_N and V_n without and with feedback. It can be shown that in most cases $V_N/A_0 = V_n/G_0$, i.e. the effective noise voltage at the input is independent of feedback.

Conditions of Versatility

The desirable characteristics of a voltage amplifier are that it should transform an input signal at low voltage and high impedance into an output signal at high voltage and low impedance with the desired gain and the minimum of phase-shift. If these characteristics are to be achieved in a single unit capable of covering a wide range of applications by simple modification, then the following design features have much to recommend them:

(1) Input to the grid of a valve, preferably having some cathode degeneration.

(2) At least two stages of voltage amplification.

(3) Cathode-follower and/or a step-down transformer output.

In addition, the amplifier must be capable of working with a large amount of overall feedback, i.e. a high loop gain. This restricts the number of significant time-constants in the loop, hence more than two stages of voltage amplification and/or transformer coupling should be avoided if a design is to remain simple.

The above considerations indicate a design based on a two-stage voltage amplifier, followed by a cathode-follower output stage, with provision for feedback from the third to the first cathode. This is known as the 'ring of three' amplifier and forms the basis of the design considered in this article.

In developing a single convertible design, the specifications to be met should be analysed and the most onerous conditions found. The concept of normalized gain deviation is useful for this purpose. The stock amplifier must

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*This article is based on an E.R.A. Report by J. Miedzinski and S. A. Patel[15], former employees of the E.R.A. It has been written in its present form by Mr. P. G. Kendall a member of the staff of the Association.

† With A' defined as the gain before the application of feedback, if a change of forward gain occurs with the application of feedback, as may be the case, the actual value of forward gain in the presence of feedback has to be used.

satisfy the most onerous value of each normalized deviation of gain or phase-angle.

Design of a Stock Amplifier

An existing stable, wide-band amplifier[1], was modified to provide an amplifier to satisfy the above requirements. About thirty amplifiers were made and found to be very successful. As a result, an order was placed for a further 120 units. At this stage the design was revised to take advantage of the experience gained by the use of the earlier type, the availability of better components and the regulated power supplies of very low output impedance[4] which had been developed.

Features such as negative bias, double-level h.t. line and d.c. heaters were excluded to reduce cost and complexity of equipment in which the amplifiers were to be used.

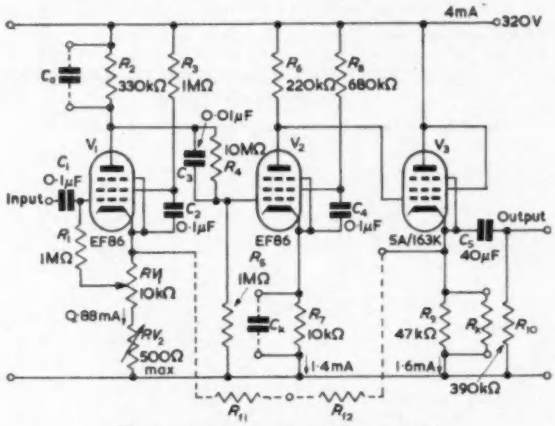


Fig. 1. Arrangement of amplifiers type VA

Broken lines show optional components not wired in stock units type VA-P

The circuit diagram of the modified amplifier is given in Fig. 1. The main features of the design are as follows:

(1) Since the amplifiers are used with low-impedance power supplies, no h.t. decoupling is needed.

(2) The only full, low-frequency, time-constant is that between V_2 and V_3. As a result, screen by-pass capacitors may be safely used. This also permits the grid leak of V_1 (R_1) to be returned to its cathode*, diluting the effect of d.c. drifts in V_3 which might otherwise put V_1 outside its linear working range.

(3) The input valve should be a pentode so that the high anode impedance reduces the transfer of signal between cathode and anode. The EF86 was chosen for its low values of microphony and hum. The choice of V_2 is not critical and it was made the same as V_1 for uniformity.

(4) The output valve must have a low output impedance at a low current drain (i.e. a high g_m/I_a ratio) and good linearity. Type 5A/163K had the lowest impedance of five valve types tested in this respect. In addition, its cathode-heater rating of 150V allows a signal of 35V r.m.s. plus 100V d.c. on its cathode with an earthed heater supply.

(5) Fine gain control is provided by RV_2. The range of this control is about 4½ per cent when $R_f \gg 10k\Omega$.

(6) The feedback resistor R_f comprises two series resistors R_{f1} and R_{f2} *to* make it easier to achieve a value within the range of the fine gain control using only standard 10 per cent tolerance (high stability) resistors.

(7) Where unity gain is required, $R_f \simeq 0$ and it is necessary to equalize the cathode potentials of V_1 and V_3 by introducing a potential divider between V_2 and V_3 similar to that between the first two stages in the standard design.

(8) The calculated normal gain is the product of that of the three stages, i.e. $22 \times 20 \times 0{\cdot}99 \simeq 440$ on no load. The long term gain stability, Δ_o, is $\pm 7{\cdot}4$ per cent for a load of 2kΩ and $\pm 5{\cdot}2$ per cent with a load greater than 200kΩ.

Construction, Cost and Performance

The amplifiers are wired in a chassis 5¼in long by 3¼in wide by 2in deep, with a front panel 3in high. No attempt was made at miniaturization; on the contrary, ample space is left for additional components and for good heat dissipation. The cost of a unit in small-scale production was £9 each, with valves but without power supplies*.

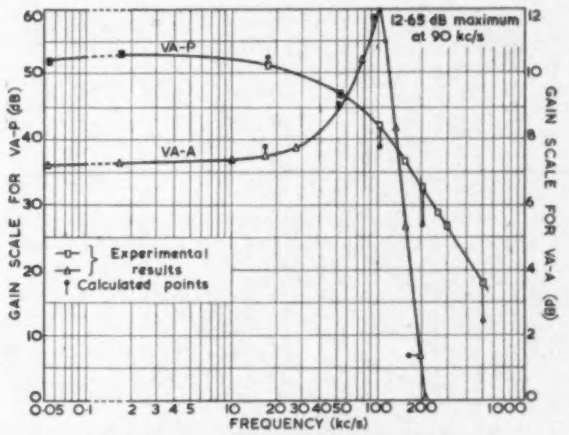

12·65 dB maximum at 90 kc/s
VA-P
VA-A
Experimental results
Calculated points
GAIN SCALE FOR VA-P (dB)
GAIN SCALE FOR VA-A (dB)
FREQUENCY (kc/s)
0·05 0·1 2 3 4 5 10 20 30 40 50 100 200 1000

Fig. 2. Frequency response of amplifiers type VA

A typical frequency response (amplitude) is shown in Fig. 2 (curve VA-P).

Tests on three amplifiers gave good agreement with the calculated values, except at the lowest and highest frequencies. The lowest frequency, 50c/s, is outside the working range. The discrepancy here is caused by the screen decoupling capacitors which are not fully effective at this frequency. The discrepancy at the highest frequency is caused by Miller capacitance at the input to the second stage. Much better agreement is obtained if an anode-grid capacitance of about 0·5pF is assumed in making the calculations. Since the capacitance across the anode load of the first stage, where the Miller capacitance appears, is usually increased to obtain the necessary staggering of the h.f. time constants, the performance of the amplifier after conversion is not affected.

The specification was met except for the phase-shift per unit gain which was more than twice too large. This could have been a serious drawback in a more conventional design, but here large undecoupled cathode resistors provide an easy means of h.f. phase correction, e.g. by shunting R_7 with a suitable capacitor C_k. This capacitance is omitted from the stock design since it is required in very few units only.

In the absence of h.t. decoupling between the stages, the

* *This connexion introduces an l.f. time-constant in the feedback circuit (R_1C_1). The importance of this constant depends on the output impedance of the source feeding V_1.*

* *The cost of a stabilizer capable of driving four amplifiers is £12 (cf. Ref. 4).*

amplifier becomes unstable when the h.t. supply impedance exceeds 3kΩ. However, a suitable decoupling could easily be provided to permit the use of unstabilized supplies.

Conversion of Stock Amplifiers

Procedure

The stock amplifier may be modified to meet any suitable specification, using the following procedure:

(1) The feedback ratio B_o is found first from the known value of A_o and the required value of G_o. Some stability coefficients (e.g. δ_o) are determined by B_o and the corresponding coefficients of the stock amplifier. These should be checked against the specified values.

(2) The modified time-constants that will satisfy the most important part of the specification may be found from the graphs of Figs. 3 to 6.

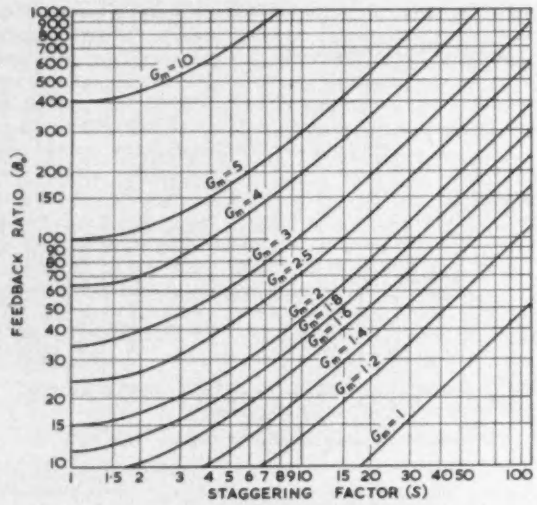


Fig. 3. Loci of constant maximum relative gain G_m

(3) If these are physically realizable, they may be used to determine completely the performance of the amplifier.

(4) When a significant discrepancy with the specification is met, the earlier parts of the design have to be modified. Some compromise and successive approximation procedure may be inevitable.

Example

This procedure may be elucidated by the example of conversion to a low gain, high stability amplifier. The specification was:

$G_o = 2{\cdot}31$, $\phi \simeq 0°$ at $\omega = 10^4$

$\delta_o \geqslant \pm 0{\cdot}1$ per cent

$\delta_f \geqslant \pm 1$ per cent

$\phi \geqslant \pm 5°$

for $10^3 \leqslant \omega \leqslant 10^5$

$G_m \geqslant 1{\cdot}5$ Bandwidth $\geqslant 200$c/s

Load: 2kΩ

Supply: 320V, highly stabilized.

Note.—The requirements for δ_o and ϕ must be satisfied; those for G_m and bandwidth are only indications of preference; $\delta_f > 1$ per cent is admissible, but 2 per cent must not be exceeded.

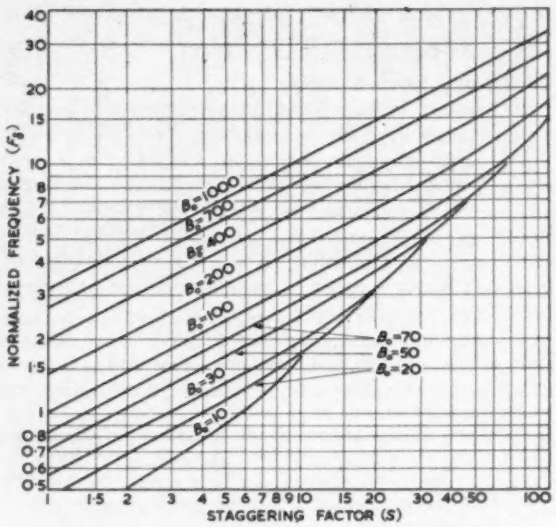
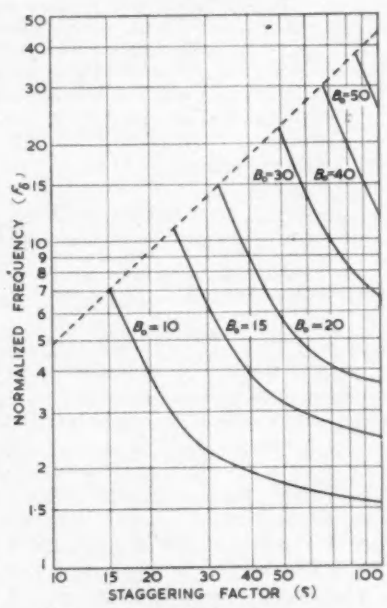


Fig. 4. (a) Frequency for amplitude deviation $\delta = +1$ per cent



(b) Frequeny for amplitude deviation $\delta = -1$ per cent

Design

For the stock amplifier,

$A_o = 440$; $\Delta_o = \pm 7{\cdot}4$ per cent; $G_o = 2{\cdot}31$

hence:

$B_o = 191$; $\Delta_o/B_o = \delta_o = 0{\cdot}04$ per cent

$G_m = 1{\cdot}5$ and $B_o = 191$ give $S \simeq 90$ (Fig. 3)

B_o and S give $F_\phi = 16{\cdot}5$ (Fig. 6, equation (19))

hence the principal h.f. time-constant is:

$$\tau = F_\phi/\omega_\phi = 16{\cdot}5/10^5 = 165\mu\text{sec}$$

The existing time-constants are 3μsec and $3{\cdot}5\mu$sec in the first and second anode respectively. There is some advantage in a reduction of bandwidth close to the input, hence τ' is chosen as $3{\cdot}5\mu$sec. This gives $S = 165/3{\cdot}5 = 47$. Re-

calculation of F_ϕ using new S gives $F_\phi = 16{\cdot}4$; $B_o = 191$ and $S = 47$ give $G_m = 2$ (Fig. 3). This is high but admissible.

B_o, S and $F = 16{\cdot}4$ for $\omega = 10^5$ give $\delta_f = 2{\cdot}6$ per cent (equation (6)). Compensating effect of the stray cathode-ground capacitance is expected to bring δ_f down to below the maximum permissible value of 2 per cent. B_o and S give $F_b = 164$ (Fig. 5), hence the actual frequency $f_b = F_b/2\pi\tau = 164$kc/s.

The above design can be accepted as satisfactory, though somewhat marginal*. If the requirements $\delta_f \gtrsim 1$ per cent and $G_m \gtrsim 1{\cdot}5$ were mandatory, they could be satisfied without great difficulty by means of cathode compensation which effectively reduces the value of τ', giving a higher S, or by introducing a phase correcting resistance in series with the staggering capacitance which must be added to increase the time-constant of the first stage to 165μsec.

The required staggering capacitance is τ/R_L where R_L

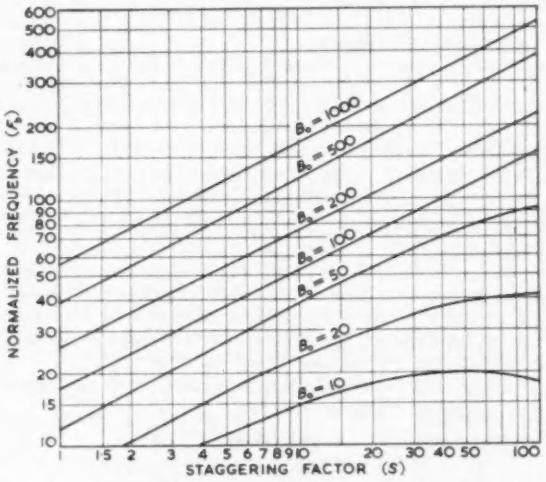


Fig. 5. Bandwidth (for 6dB loss of gain)

is the dynamic anode load in the first stage, the valve being treated as a current generator†. Putting $R_L = 250$kΩ gives $C_a = 660$pF less existing anode-ground strays, i.e. $C \simeq 660$pF.

The feedback resistance $R_f = R_{k1}(1/\beta - 1)$ where R_{k1} is the cathode resistance in the input stage and $1/\beta = A_o/(B_o - 1)$.

This gives $R_f = 1{\cdot}31 \times 10\text{k}\Omega = 13{\cdot}1\text{k}\Omega$.

Performance

The frequency response of the amplifier is shown in Fig. 2 (curve VA-A). The results were rather better than the calculated values, as expected, and were completely satisfactory.

The time-dependent gain deviation was tested by artificial introduction of very large drifts. The specification for 0·1 per cent stability was satisfied many times over for any drifts of a practical magnitude. Agreement with the calculated values was also very good. The tests did not take into account gain deviation which might occur due to changes in the passive feedback network. Such changes are governed by the type of resistors used and the range of temperature variation.

* *The l.f. performance can be seen to be satisfactory without calculation.*

† *R_L = parallel combination of the anode load (330kΩ), grid leak (1MΩ) and anode resistance of the valve (~7MΩ in absence of cathode feedback, much higher with it).*

Conclusions

Substantial economies in time and materials may be effected by carrying a stock of one to three standard types of amplifier unit. These units can be bulk-produced at low cost, can be readily converted so that their performance complies with the requirements of any of a large number of specifications, and are always ready at hand.

This policy has been found to be successful in practice, because a design procedure has been developed which facilitates rapid determination of the modifications which are required to satisfy a given specification.

A number of designs of amplifier have been constructed in this way to satisfy a wide range of requirements, and have successfully passed a long period of trial in the analyser.

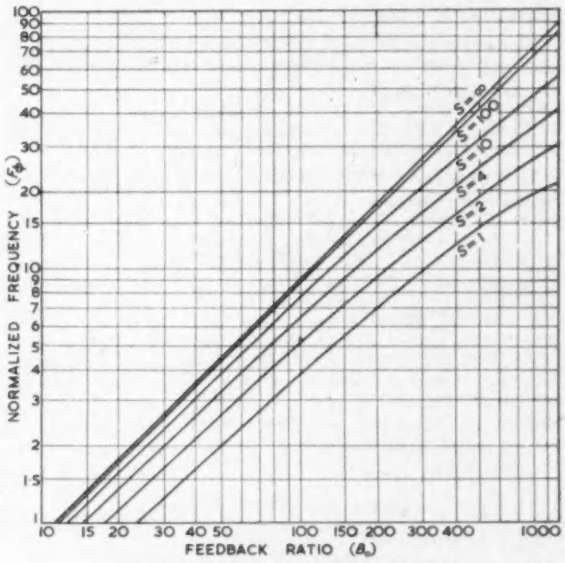


Fig. 6. Frequency for phase-shift $\phi = 5°$

All the designs so far produced have been for amplifiers operating with low-level signals on an output impedance of about 400Ω (without feedback). Greater versatility would be attained by the development of designs for amplifiers capable of producing outputs of greater power at lower impedance

The cost and size, which are already small, could be further reduced by recourse to mass-production and miniaturization (e.g. by means of printed circuits).

Appendix

Feedback Analysis

Method of Approach

The elementary and the advanced analysis of feedback amplifiers are both fully covered in the existing literature, (see Bibliography). The purpose of this section is to facilitate the use of a known, basic method of design by listing the relevant formulae and providing sets of curves for graphical solutions. It is assumed that a straight amplifier of sufficiently good performance is already available. This amplifier must have no more than two significant l.f. and/or h.f. time-constants in the path to which feedback is to be applied. The design procedure is limited to the problem of finding the feedback and staggering components required to make the response match a given specification. The complete symmetry existing between the effects of the

l.f. and h.f. time-constants permits restriction of the treatment to the h.f. case only. The l.f. solutions can be found from the corresponding h.f. results by using the appropriate time-constants and inverting the normalized frequency.

The analysis applies to complete time-constants. If a partial time-constant be treated as a complete one, the results will be on the conservative side.

Mathematical expressions are derived in terms of the mid-band feedback ratio B_o, rather than the mid-band loop gain βA_o. This simplifies the expressions; furthermore, B_o is experimentally much easier to measure, so that βA_o is usually calculated from it.

Throughout the analysis, steady state response alone is considered.

Mathematical Treatment

Elementary analysis of a linear amplifier with two complete h.f. time constants shows its complex forward gain A'' to be (putting $\Delta_o = 0$):

$$A'' = \frac{A_o}{(1 + j\omega\tau)(1 + j\omega\tau')} = \frac{A_o}{(1 + jF)(1 + jF/S)} \quad \ldots (3)$$

In the presence of overall negative feedback, the complex overall gain becomes G'':

$$G'' = \frac{A''}{1 + \beta A''} = A''/B'' \quad \ldots\ldots\ldots\ldots (4)$$

Normalizing G'' with respect to G_o, the relative gain G_r'' is obtained,

$$G_r'' = G''/G_o = (A''/A_o)(B_o/B'') = \frac{B_oS}{(B_oS - F^2) + j(1+S)F} \quad \ldots\ldots\ldots\ldots (5)$$

or:

$$G_r'' = G_r e^{j\phi}$$

$$G_r = G/G_o = \frac{\{F^4 - [2B_oS - (1+S)^2]F^2 + B_o^2S^2\}^{\frac{1}{2}}}{B_oS} = 1 \pm \delta_f \quad \ldots (6)$$

$$\phi = -\tan^{-1}\frac{(1 + S)F}{B_oS - F^2} = -\tan^{-1}\frac{(1 + 1/S)F/B_o}{1 - F^2/B_oS} \quad \ldots (7)$$

Differentiating equation (6) with respect to F and rejecting solutions corresponding to $F < 0$, $F = 0$, or $S < 1$, it is found that equation (6) is monotonic when:

$$B_o < \frac{(1 + S)^2}{2S} \quad \ldots\ldots\ldots\ldots (8)$$

(cf. Fig. 2, response of VA-P) but has maximum when:

$$B_o > \frac{(1 + S)^2}{2S} \quad \ldots\ldots\ldots\ldots (9)$$

(cf. Fig. 2, response of VA-A).

The marginal case $B_o = (1 + S)^2/2S$ gives the so-called critically damped amplifier.

The maximum value G_m of the relative gain G_r for an underdamped amplifier is a measure of its circuit stability, since the stability is zero (oscillation) when $G_r = \infty$. A large rise of gain is objectionable even when it occurs outside the working frequency band and without any danger of oscillation, because of its adverse effect on the transient response and the total noise output. G_m is given by:

$$G_m = \frac{2B_oS}{(1 + S)[4B_oS - (1 + S)^2]^{\frac{1}{2}}}$$

This may be rewritten:

$$B_o = [(S/2) + 1 + (1/2S)][G_m^2 + G_m\sqrt{(G_m^2 - 1)}] \quad \ldots (10)$$

Solutions of equation (10) for G_m are given in Fig. 3.

The frequency F_m of maximum gain is:

$$F_m = (B_oS)^{\frac{1}{2}}[1 - (2 + S + 1/S)/2B_o]^{\frac{1}{2}} \quad \ldots\ldots (11)$$

Another frequency of interest to the designer is the frequency F_δ at which the relative gain deviates from unity by a given ratio:

$$G_r = 1 \pm \delta$$

$$F_\delta = F_m\left[1 \pm \left(1 - \frac{B_o^2S^2}{F_m^4}\cdot\frac{G_r^2 - 1}{G_r^2}\right)^{\frac{1}{2}}\right]^{\frac{1}{2}} \quad \ldots (12)$$

$$= F_m[1 \pm (1 - 2\delta B_o^2S^2/F_m^4)^{\frac{1}{2}}]^{\frac{1}{2}} \text{ for } \delta \ll 1 \quad \ldots (13)$$

The above equation has in general three solutions:

(a) Positive deviation, rising gain (i.e. $F_\delta < F_m$).

Putting $2\delta B_o^2S^2/F_m^4 = q$:

$$F_\delta = F_m[1 - (1 - q)^{\frac{1}{2}}]^{\frac{1}{2}} \simeq (B_oS)^{\frac{1}{2}}/[1 - (2 + S + 1/S)/2B_o]^{\frac{1}{2}} \quad \ldots\ldots\ldots\ldots (14)$$

for $q < \frac{1}{4}$.

(b) Positive deviation, falling gain (i.e. $F_o > F_m$):

$$F_\delta = F_m[1 + (1 - q)^{\frac{1}{2}}]^{\frac{1}{2}} \simeq \sqrt{2}F_m \text{ for } q \ll 1 \quad \ldots (15)$$

(c) Negative deviation:

$$F_\delta = [F_m^2 + (F_m^4 + 2\delta B_o^2S^2)^{\frac{1}{2}}]^{\frac{1}{2}} \quad \ldots\ldots\ldots (16)$$

Solutions (a) and (b) exist only when F_m is real and $G_m > 1 + \delta$; (c) always exists, but is of practical interest only when item (a) does not exist; (b) is never important.

The frequency range within which gain is constant to ± 1 per cent is often of interest. The corresponding solutions of equations (14) and (16) are given in Figs. 4(a) and (b).

The noise bandwidth of an amplifier is also of importance. The exact solution is rather complicated, but an approximate result can easily be obtained by taking the bandwidth between the points at which gain is down by 6dB. The l.f. end of the band may be taken as $F = 0$ when the response extends down to a few cycles per second, the difference being insignificant.

Substituting $G_r = \frac{1}{2}$ in equation (12) gives:

$$F_b = [F_m^2 + (F_m^4 + 3B_o^2S^2)^{\frac{1}{2}}]^{\frac{1}{2}} \simeq \sqrt{(3B_oS)} \text{ for } B_o > S \quad \ldots (17)$$

where F_b represents the upper 6dB point. Graphs of F_b are given in Fig. 5.

When a maximum phase-shift ϕ is specified, the corresponding frequency F_ϕ may be found from equation (7) as:

$$F_\phi = \frac{1 + S}{2\tan\phi}\left\{1 - \left[1 + \frac{4\tan^2\phi\, B_oS}{(1 + S)^2}\right]^{\frac{1}{2}}\right\} \quad \ldots (18)$$

$$\simeq -\frac{B_o\tan\phi}{1 + 1/S} \text{ for } \frac{4\tan^2\phi\, B_oS}{(1 + S)^2} < \frac{1}{4} \quad \ldots (19)$$

with ϕ and $\tan\phi$ negative for h.f. phase-shifts less than $\pi/2$. This relation is shown in Fig. 6 for the case of $\phi = 5°$.

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BOOK REVIEWS

Field Theory of Guided Waves

By R. E. Collin. 606 pp. 222 figs. Medium 8vo. McGraw Hill Book Co. 1960. Price £6 8s.

IN the past dozen years or so, interest in guided waves in complicated systems has been growing rapidly, and a great number of new structures have been investigated. As the author says in the preface, it is surprising that "a comprehensive account of guided-wave theory at the graduate level has not appeared in text-book form". He goes on: "This book is an attempt to bridge the gap between the usual senior - first - year - graduate treatment . . . and the more advanced topics which are of prime importance to the graduate student and the research worker in the field." The book is written at considerably above the graduate level, and as a bridge to the gap it will be heavy going for the electrical engineer or physicist who wants to understand the theory of waveguides. It is more suitable for the applied mathematician who wants to apply his mathematics to electromagnetic problems. The emphasis is on the mathematical techniques used, rather than on the results obtained, so that the reader who masters the contents of this book will also need to make an extensive study of the literature before he can be regarded as knowledgeable about waveguides.

About 35 per cent of the book is devoted to basic theory, both electromagnetism and mathematics, in four chapters entitled "Basic Electromagnetic Theory", "Green's Functions", "Transverse Electromagnetic Waves", "Integral Transforms and Function - Theoretic Techniques", and a mathematical appendix. No discussion of units is given; this is a common fault in books on electromagnetic theory, but a serious one.

Forty per cent of the book deals with guided waves proper, in five chapters entitled "Transmission Lines", "Propagation in Cylindrical Waveguides", "Inhomogeneously Filled Waveguides", "Periodic Structures", and "Surface Waveguides", The chapter on inhomogeneously filled guides is very limited in content, dealing only with guides of rectangular cross-section loaded with slabs of dielectric or ferrite extending across the whole of one dimension of the cross-section. This chapter is mainly concerned with mathematical methods, and gives no account of the properties of the guides treated; under the heading "Ferrite Slabs in Rectangular Guide" the words "phase-shifter", "isolator", and "circulator" do not appear, although non-reciprocity receives passing mention. No mention is made of guides of circular cross-section containing dielectrics or ferrites, nor of the helix guide.

Finally, 25 per cent of the book is given to miscellaneous topics in three chapters entitled "Excitation of Waveguides", "Variational Methods for Waveguide Discontinuities", and "Artificial Dielectrics". The only notable omission is any account of propagation in horns.

The book has a readable style, but viewed as a whole gives the impression of a collection of topics rather than a logical development of a subject. A great deal of well-treated material is presented, of value to research workers in the field of guided-wave theory. There are a few trivial errors; no serious errors were noted.

R. A. WALDRON

Electrical Theory on the Giorgi System

By P. Cornelius. 187 pp. 28 figs. Demy 8vo. Cleaver Hume Press Ltd. 1961. Price 32s.

THE treatment in this book is aimed at a technical level rather lower and less rigorous than that of the University honours degree, a level which in terms of the author's preface should serve "the ambitious radio technician, the engineer, and the experimental physicist". The opponents of the m.k.s. system are obstinate, but one feels that if they gave this book a fair reading they would have to admit that there is no fundamental scientific or pedagogic objection to the system, even though they might still prefer the c.g.s. system. The theory is founded throughout on experimental arguments, and perhaps this is why the author hopes it will appeal to the experimental physicist; but the author always has in mind his ambitious radio technician, and the graduate engineer or physicist would benefit from a fuller discussion of points such as the way in which the concept of displacement current makes the generalized electric current a quantity which is always continuous. The mathematics, too, is rationed. Perhaps a vector analysis of some of the points could have been put in an appendix.

Chapter 1 deals with pure electrical (and electromagnetic) laws, and chapter 2 deals with mechanical forces in electric and magnetic fields. The exclusion of vector mathematics requires that consideration of the force between two currents be limited to the special case of two thin parallel wires and that the Lorenz force on an electron be stated for the case of velocity at right-angles to the magnetic field.

An unusual but valuable feature of the book is that nearly half of it is devoted to "Selected problems in electrical theory". The first and most thorny of these problems is whether there is a difference between E and D and between B and H, but the author rightly points out that the use of the Giorgi system of units does not pre-judge this issue. There follows an explanation of the responses of uniform transmission lines to pulse and to sinusoidal excitation, calculation of the parameters of parallel-strip, concentric and parallel-wire transmission lines, and skin effect near a surface which may be approximated by a plane. After a brief look at radio receiving aerials, the principle of the dynamo, and the dielectric and magnetic polarization, this part of the book ends with an analysis of demagnetizing effects in permanent magnets.

Chapter 5 is a further defence of the Giorgi system; and chapter 6 gives extensive tables for the conversion between different systems of units of electrical quantities and formulae. The latter include one or two. e.g. the Poynting vector. the Clausius Mosotti law and the radiated field from a short dipole aerial, which are not covered in the text. It will do no harm to anyone to read this book, and it should meet the requirements of H.N.C. or the earlier years of a degree or Dip. Tech.

D. A. BELL

Introduction to the Statistical Dynamics of Automatic Control Systems

By V. V. Solodovnikov. 307 pp. 92 figs. Demy 8vo. Dover Publications Inc., New York. 1960. Price $2.25.

THIS book is a translation of the work of a leading Soviet engineer, first published in 1952 in an attempt to gather together various papers on prediction theory applied to the problems of random information in automatic control systems.

Assuming that the reader is familiar with Fourier transformations the first two chapters deal with simple laws of the theory of probability, then follows an indication of the basic principles and applications of random process theory and the estimation of mean-squared errors.

Later chapters indicate methods of obtaining transfer functions of a system for which a minimum mean-squared error has been stated related to its signal and noise properties and applications of the technique to problems of smoothing and prediction are included.

This work will be of special interest to students and engineers dealing in control problems which are of a random nature rather than those where the system is related to functions of time.

It is well written in a clear style and seems to have suffered little from translation. A comprehensive bibliography in the form of footnotes covers every aspect of the subject matter both from internal Soviet and international sources.

Although most of the information was available in individual papers, or in the original Russian some years ago, it is a book which will aid the designer of automatic control systems as well as serving as a useful text book for students of this subject.

A. W. PEARSON

Physics of Semiconductors

By A. F. Ioffe. 436 pp. 176 figs. Royal 8vo. Cleaver Hume Press Ltd. 1960. Price 84s.

THIS book is a translation of a Russian text on semiconductors and therefore something of an event, especially since the author has an eminent name in solid state physics. After a long-term diet of chicken Maryland, roast beef, and escargot, one relishes the thought of caviare, and when the opportunity arises one sits down to enjoy it with anticipation. It is irritating to find oneself being distracted by the Russian salad. But the irritation does not last. One gets used to the idea that Auger recombination is also Sosnovskii recombination just as one gets used to the paucity of references to American work, and it is comforting to find that "much work has been done abroad on semiconductor theory". The book, of course, was not intended originally for international consumption and although it was revised by the author for the English edition, it still carries the strong flavour of having been directed at Russian solid state technicians.

All deep mathematical theory is avoided but to compensate, the scope is great and the properties of a large number of semiconductors find their way into the text. The treatment, though aimed at presenting the main ideas and results for the purpose of technically controlling the properties of semiconductors, is by no means shallow. On the contrary Ioffe's discussion on the inadequacy of band structure concepts when applied to the transition between solid and liquid semiconductors and also generally to low mobility semiconductors plunges into depths all too often avoided in textbooks. His assessment of the present state of semiconductor science in the final chapter is brilliant and no one in this field should fail to read it.

In form, the book is in three parts plus the brilliant coda. The four chapters of the first part jog the reader over the whole range of the subject with short clear paragraphs. The treatment is elementary but occasionally there is a slip as when the term phonon is introduced without explanation. The long fifth chapter is the second part and core of the book. It is devoted to an account of physical phenomena in semiconductors ranging from short and long range ordering effects over the whole gamut of mechanical, electrical, magnetic, thermal and optical properties to pn junctions and transistor action. Inevitably in this sort of exposition there is repetition. While this is presumably good for teaching purposes it reduces the value of the book as a source of easy reference. The easy exposition followed by a more difficult development section—or sonata form—approach will always have this defect. The third part, in two chapters, deals with methods of measurement and describes various types of semiconducting materials.

The translator has done an excellent job. The book reads extremely well, except when one finds that the lattice scattering mobility increases, instead of decreases, when the temperature rises, or when one comes across the diffusion coefficient for electrons in germanium given as $0{\cdot}1 cm^2/sec$ instead of $100 cm^2/sec$. But these are mere trivialia and, on the whole, the translator and publisher have produced a pleasing addition to the semiconductor library.

Professor Ioffe in writing an introduction to semiconductors for Russian technicians, which might well have been humdrum, has produced a fresh and stimulating work which should claim the attention of the sorcerer as well as his apprentice.

B. K. RIDLEY

Engineering Mathematics

By J. Blakey & M. Hutton. 603 pp. 22 figs. Medium 8vo. Blackie & Sons Ltd. 1960. Price 40s.

DR. BLAKEY'S "University Mathematics" is well-known as a suitable text-book for students taking ancillary mathematics for external degrees in the University of London, or similar courses and examinations. Each section is completed by a set of worked examples, so that anyone studying the text carefully can tackle with considerable confidence the examples at the end of each chapter.

The present book has precisely the same qualities and is likely to be very successful with the same type of student. It must be made clear, indeed, that it is almost the same book, with chapters added on relaxation methods, numerical solution of equations, Laplace transforms and statistics, and chapters omitted on general conics and solid geometry. About one hundred and fifty pages are new.

The inclusion of these new chapters, on topics which are presumably now examined at this level, raises many questions. It can possibly be argued that partial differential equations should be solved numerically and even by relaxation methods before they are solved analytically; but surely some explanation ought to be given as to the reasons for using particular methods. Again, why solve ordinary differential equations with constant coefficients at length by the D-operator method, and then again by Laplace transforms, in the same book, in different chapters?

There are so many more interesting things to talk about nowadays in books for engineers, that these chapters seem rather trivial. When mechanical engineers are tying themselves in knots—and untying themselves—with complicated problems using vectors, variational methods and characteristics, and electrical engineers are puzzling over matrices and tensors and realizing the beauty of the theory of functions of a complex variable, surely a little more interest can be put into their mathematics?

G. J. KYNCH

Electronic Fundamentals and Applications

By J. D. Ryder. 721 pp. 493 figs. Medium 8vo. Sir Isaac Pitman. 1960. Price 60s.

DURING the last decade there has been available some ten or twelve electronics textbooks suitable for students reading for a University Degree in Electrical Engineering. These books cover approximately the same material and the differences between them are more a matter of style and emphasis rather than of content: almost all of these books originate in the U.S.A. Among these texts "Electronic Engineering Principles" and "Electronic Engineering Fundamentals and Applications" by J. D. Ryder are fairly well known. Professor Ryder has now brought the second of these books up to date with a new edition which includes a substantial amount of material on transistors.

The contents of the book can be roughly divided into chapters dealing with thermionic valves, chapters on transistors and chapters dealing with principles and applications common to both valves and transistors. The material on thermionics is virtually the same as in the previous volume; it includes two excellent chapters on the behaviour of charged particles in magnetic and electric fields, chapters on power supplies, modulation, de-modulation, gaseous conduction and gas-filled valves. The treatment of this traditional material is sometimes rather too detailed for present-day needs; for example the analysis of the cathode-follower could be much simplified with no real loss of understanding and a whole chapter devoted to large-signal radio frequency amplifiers seems inappropriate in a text of this nature. On the other hand the chapter on power supplies does not mention voltage stabilizers although this device is briefly described in the chapter on feedback. The ground is prepared for transistor analysis by a short chapter on the properties of 4-terminal networks. The transistor is now introduced and it is perhaps a pity that the various characteristics are drawn on non-conventional axes and refer to a very poor transistor ($\beta = 14$!). The analysis considers the properties of the three usual transistor configurations in terms of the T and the corresponding hybrid parameters. Those transistor properties, such as hole

storage, which are important in pulse applications are not discussed. The remainder of the book deals with amplifiers, oscillators and wave-shaping circuits from the point of view of both the valve and the transistor. Both small-signal and large-signal amplifiers are covered very thoroughly but the use of transistors in pulse circuits receives relatively little attention.

This is a comprehensive and useful book and by present standards it is by no means expensive. However, there is a number of instances where the analytical work is unduly complex and could well be simplified.

V. H. ATTREE

Electronics and Nucleonics Dictionary

By N. M. Cooke and J. Markus. 543 figs. 450 figs. Medium 8vo. McGraw Hill Publishing Ltd. 1960. Price 93s.

THIS is an illustrated dictionary giving definitions, abbreviations and synonyms for some 13 000 terms used in television, radio, medical electronics, industrial electronics, space electronics, military electronics, nuclear science and nuclear engineering.

Some 400 illustrations clarify and expand the meanings of the more complex terms, and show examples of typical circuits and devices.

Electronic Maintainability Vol. 3

By F. L. Ankenbrandt. 312 pp. 58 figs. Medium 8vo. Reinhold Publishing Corpn. 1961. Price 80s.

THIS book is really the Proceedings of a Conference on "Maintainability of Electronic Equipment" held in San Antonio, Texas, sponsored by the Electronic Industries Association in the U.S.A. Although the book was published in 1960, the actual date of the conference is not given, other than the "Third" Conference, so presumably the information is about a year old. There is, naturally, a great deal of information in this book, but there is no coherent story and one finds the same basic points repeated over and over again in successive papers. To the British reader the phraseology is sometimes difficult to understand—for instance, the first sentence in the Preface reads: "Maintainability is a product characteristic concerning the effort and cost necessary to keep an equipment in usable condition, and to return it to usable condition after a malfunction has occurred."

There are 28 papers reproduced in the book, including initial Army, Navy and Air Force "Outlook" papers on maintainability, followed by airlines and military papers on almost every aspect of the problem of maintaining electronic equipment. There is a tendency to 'pad out' information in many cases and one is left with the impression that 'two page summaries' would contain 90 per cent of the relevant information.

However, there is no doubt that the book records the valuable experience obtained in the U.S.A. on maintaining complex electronic equipments, but its price (80s.) is very high, even for British libraries.

G. W. A. DUMMER

Electrical Noise

By W. R. Bennett. 280 pp. 106 figs. McGraw-Hill Book Company, Inc., New York, Toronto, London. 1960. Price 77s. 6d.

IN dealing with electrical noise a writer can approach the subject from the point of view of the noise sources themselves, or of the effects on circuits, or of mathematical analysis. The present volume is inclined to the middle course, that of making noise palatable to the communications engineer.

A feature of the book is the lack of insistence on Fourier analysis until a late chapter. This is achieved by the artifice of assuming that noise energy is present, and spread over all frequencies, and finding the properties this noise must have. For analysis the effects on a simple tuned circuit are calculated in terms of the circuit bandwidth and conductance. This forms a very suitable approach for the circuit engineer, in that his attention is not diverted at the start by mathematical difficulties.

Following a treatment of thermal noise in this manner, the third chapter deals with the distribution of magnitudes in noise. Since this brings in probability, it could well have been left until later, after the other noise sources had been covered.

The fourth chapter deals with noise in vacuum tubes (meaning diodes and grid controlled types), and here the author has to pursue the unusual course of concentrating on noise at high frequencies and deriving the medium frequency noise formula as a limiting value. It is unfortunate that the role of the relatively longer length of the current pulses at higher frequencies is obscured by this treatment. Noise in semiconductors, both shot noise and l.f. noise is dealt with in chapter five. This is followed by an interesting discussion of noise in electromagnetic radiation, and the relation of thermal noise to black-body radiation, leading on to interaction between radiation and matter, and the theory of noise in masers.

Noise generating equipment and noise measurement are dealt with briefly and are followed by the design of low noise equipment. Into this latter chapter are crowded triode and transistor amplifiers, a brief mention of travelling-wave tubes, and discussion of reactance amplifiers and the Haus-Adler theory of noise measurement. This material is far too condensed, especially as the travelling-wave tube information is not up-to-date, and only two lines are devoted to electron beam parametric amplifiers. Chapter 10 brings the inevitable application of Fourier analysis and the book finishes with a good discussion of noise in communication systems.

The volume is well referenced in each chapter and, from its different method of approach, forms a very useful addition to the growing number of books on noise.

W. H. ALDOUS

EE 33 117 *for further details*

CHAPMAN & HALL

NOISE IN ELECTRONIC DEVICES

Published for

THE INSTITUTE OF PHYSICS

and

THE PHYSICAL SOCIETY

Papers based on material from a conference held by the Institute of Physics' Electronics Group in October 1959. The contents vary from a concise yet complete account of noise phenomena to some new considerations of noise in valves, and cover various particular electronic devices in between. *Illustrated.* 35*s. net*

37 ESSEX STREET, LONDON, W.C.2

Laboratory and Workshop Notes 1956-1958

Compiled and Edited by R. Lang. 218 pp. 149 figs. Pott 4to. Edward Arnold Ltd. 1960. 5th Edition. Price 40s.

IT is now ten years since the introduction of this series of Notes which are reprinted from the Journal of Scientific Instruments. This fifth selection has again been compiled by Dr. Ruth Lang at the invitation of the Board of The Institute of Physics. As in the previous volumes some Notes have been slightly condensed by omitting introductory paragraphs and acknowledgments.

Spectra and Analysis

By A. A. Kharkevich. 222 pp. 61 figs. Medium 8vo. Consultants Bureau Enterprises Inc. 1960. Price $8.75.

THIS book has been translated from the revised third edition of the Russian text published by the State Press for Technical and Theoretical Literature, Moscow, in 1957.

LETTERS TO THE EDITOR

(We do not hold ourselves responsible for the opinions of our correspondents)

The Schmitt Type of Trigger Circuit

DEAR SIR,—Recently we required a Schmitt type of trigger circuit with different on and off levels and the circuit of Fig. 1 was developed for this application. The operation of the circuit is as follows. With transistor VT_2 on and

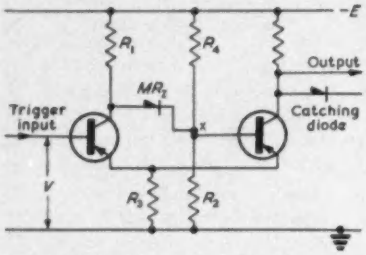


Fig. 1. Trigger circuit with different on and off levels

VT_1 off the voltage V_1 at point x is defined by R_1, R_2 and the Zener diode MR_Z. The current through R_4 is very much less than that through MR_Z and VT_2 must be prevented from bottoming.

Thus $V_1 = -[E - Z]R_2/(R_1 + R_2)$ where Z is the Zener voltage of MR_Z. As the input voltage V approaches V_1 from the 'ground' VT_1 switches on and VT_2 off in the usual Schmitt manner. With VT_1 on, however, the Zener diode is biased off, and the voltage V_2 at x is now defined by R_3 and R_4 only.

Thus $V_2 = -ER_3/(R_3+R_4)$

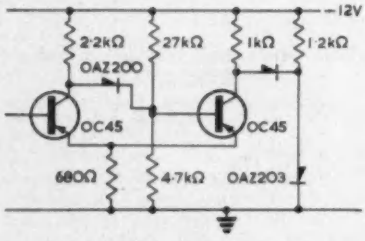


Fig. 2. Circuit for level differences greater than 2·5V

$V_1 \simeq 5V$, $V_2 = 2V$, $Z = \simeq 4{\cdot}7V$

The circuit cannot switch again until the input voltage V 'falls' to V_2. The values of R_1 and R_2 must be chosen so that the voltage across MR_Z does not approach V_2 before this happens. In practice the difference between V_2 and V_1 is limited by this consideration. Despite this, circuits have been designed with $V_1 - V_2$ greater than 2·5V. Fig. 2 is such a circuit in which the switching times are better than 1μsec, although only medium speed transistors are used. Indeed the switching time from VT_2 on to off is very fast because of the low dynamic impedance of MR_Z in its Zener state. The basic circuit of Fig. 1 can be modified as in Fig. 3 to give a circuit with very little backlash. With VT_1 off and VT_2 on the voltage V_1 at x is defined as before by R_1, R_2 and Zener diode MR_1. The voltage at y is set very slightly negative with respect to x. Because of the non-linearity of MR_2 very little current is taken through it. With VT_1 on and VT_2 off the voltage V_2 at x is only slightly positive compared with V_1 and thus the backlash is made very small. Fig. 4 is a

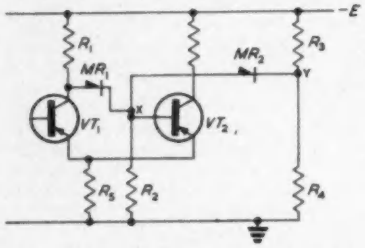


Fig. 3. A modification to reduce backlash

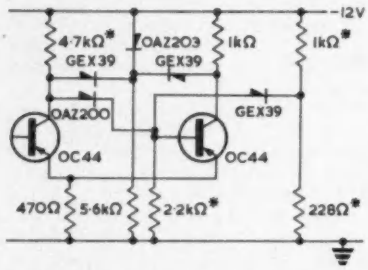


Fig. 4. A practical circuit with less than 100mV backlash

** 1 per cent tolerance*

practical circuit in which the backlash using standard components is less than 100mV. The use of a variable resistor in place of R_3 and R_4 enables the backlash to be reduced below this value.

Yours faithfully,

P. C. DEARLOVE,
British Scientific Instrument
Research Association, Chislehurst.

A Read-Out System for Transistor Scalers

DEAR SIR,—In Mr. T. G. Benbow's article entitled "Read-out Systems for Transistor Scalers" which appeared in the December 1960 issue of ELECTRONIC ENGINEERING the author compares three read-out methods for decade transistor scalers.

The author concludes that, although more expensive, the third solution with a neon tube indicator fired by an auxiliary transistor is to be preferred for some advantages which it offers. But it is obvious that this solution has the disadvantage of requiring a special transistor with a high collector-base voltage.

The following is a description of a new circuit which can be built with normal low voltage transistors.

Consider a bistable circuit, Fig. 1, which is the basic component of any type of scaler.

It is well known that if one wishes this circuit to be suitable for high counting rates it is necessary to keep the current and the sudden voltage changes as small as possible.

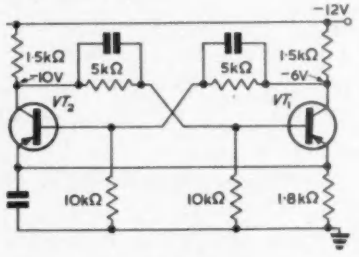


Fig. 1. A bistable circuit

Suppose that VT_1 is normally conducting and VT_2 is normally cut-off; the collector voltage for VT_1 is $-6V$ and for VT_2 is approximately $-10V$.

If a trigger pulse appears, the circuit will change its state and the collector of VT_2 will rise to $-6V$, and this positive pulse of 4V is to be read out.

The circuit developed for read-out is shown in Fig. 2. In this circuit a neon bulb indicator (N_1) is supplied by a d.c. source (+40V) and with negative going pulses through a load resistor R_1.

A capacitor, C, connects the cathode of the neon tube to the collector of an auxiliary transistor $-VT_2$, which is supplied with $-12V$ through the load resistor (R_2—which has a high value) and which has its emitter connected to $-6V$. Through a limiting resistor it has its base connected to the collector of VT_2.

When this collector is at $-6V$ the base-emitter voltage for VT_2 is zero and the transistor is cut-off. The neon tube, although having CR_2 in parallel, is fired.

When the collector of VT_2 is at $-10V$ the base-emitter voltage of VT_2 is negative and VT_2 therefore will be on and

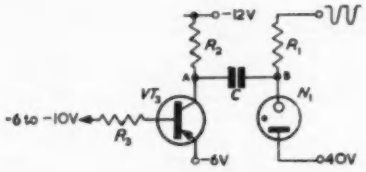


Fig. 2. The read-out circuit

passing a current limited by R_2. But, in this case, the point A is practically grounded for the negative going pulses which are supplying the neon tube indicator (in addition to the d.c. supply) and these pulses are short-circuited. As a result the neon tube is cut-off.

This circuit has the advantage that for direct current conditions it operates with a low voltage supply (−12V) but it can operate at a higher pulsed voltage (25 to 50V) without damaging the transistor (which allows a higher collector voltage in pulse operation).

The amplitude of negative going pulses must be chosen so as not to exceed the maximum rated voltage for the transistor.

The read-out system proposed has the following advantages:

It operates with normal low-voltage transistors.

It requires small currents for the control of the neon tube (10 to 20μA) and by this it enables high counting rates for the bistable circuit.

It needs few electronic components (three resistors and one capacitor).

This system needs an auxiliary supply for the negative going pulses. But if it is to be used in a portable (or laboratory) counting equipment the question is solved by the supply which feeds the radiation detector.

The author wishes to give thanks for valuable discussions to Messrs H. Totea and T. Teitel and to Mr. V. Anghelescu for constructing the models and for the interest with which he verified their performances.

Yours faithfully,

M. BIRNBAUM,
Institulal de Fizica Atomica,
Rumania.

A Novel Single Transistor RC Oscillator

DEAR SIR,—The use of a transistor in lieu of a valve in a parallel-T oscillator introduces matching difficulties due to the different range of impedance values of the former as compared with the impedance of a valve.

Mr. E. T. Emms in the August 1960 issue overcomes these difficulties by interchanging the terminals of the RC network and using the transistor in the common base connexion.

A different approach may consist in a comprehensive study of the unmodified circuit in order to find out a possible set of values for the various parameters which ensure satisfactory behaviour. This was done by me a few years ago[1].

Let the complete circuit and its equivalent be as drawn in Fig. 1(a) and (b). The latter introduces, as may be seen, some simplification acceptable for the purpose of the application considered here.

A rather lengthy but simple algebra leads to the two conditions:

$$(g_i/G) = P_1(sx - v^2ty) + v^2P_2(tx + sy) + \alpha x + \gamma s$$
$$0 = P_1(tx + sy) - P_2(sx - v^2ty) + \alpha y + \gamma t$$

where:

$$s = 1 + (G_r/2G);\ t = 1 + (C_r/\alpha C);$$
$$x = 1 + (G_i/\alpha G);\ y = 1 + (C_i/\gamma C)$$

and

$$P_1 = \frac{\delta^2 + v^2 - \delta(\delta^2 + 1 + v^2)}{v^2(\delta^2 + v^2) + \delta^2 + 1/v^2 - 2\delta(1 + v^2)}$$

$$P_2 = \frac{\delta^2 + 1/v^2 - \delta(\delta^2 + v^2)}{v^2(\delta^2 + v^2) + \delta^2 + 1/v^2 - 2\delta(1 + v^2)}$$

with: $\delta = \alpha + \gamma;\ v = \omega C/G.$

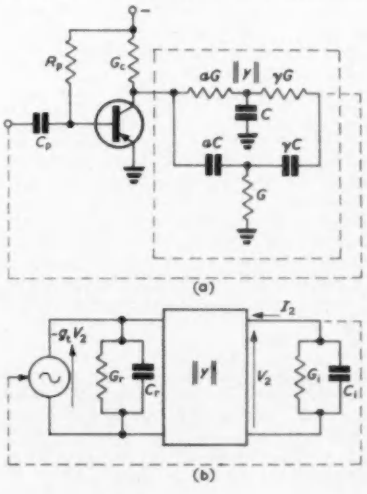
The two conditions define the frequency of oscillation and a relationship to be satisfied in the design of the circuit.

One realizes that the conditions in fact include some of the transistor parameters which are not constant but their influence on the behaviour of the circuit can be reduced to an acceptable level by a proper choice of the RC network parameters.

The choice is fundamentally one of low values for the network impedances in order to reduce substantially the influence of the low input impedance of the transistor.

On the contrary its output impedance

Fig. 1. The complete circuit and its equivalent



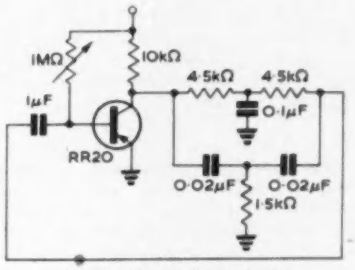


Fig. 2. The oscillator circuit

can be generally overlooked since it is paralleled by G_c.

An example of an oscillator designed according to this philosophy was to be found in the article already cited. It is given in Fig. 2 in order to show the various parameter values. A frequency stability better than 3×10^{-4} over a few hours was then measured.

A more complete investigation of the frequency and amplitude stabilities of this type of oscillator[2] has proved that they are better than for other types of RC oscillators.

This type of oscillator is however less convenient when the frequency must be varied over a wide range since the resistance can be made to vary only over a limited extent.

Yours faithfully,

G. FRANCINI,
Universita di Padova, Italy.

REFERENCES

1. FRANCINI, G. Oscillatore a resistenza e capacita con transistore. *Alta Frequenza*, *25*, 210 (1950).
2. ZANINI, A. Misure sulla qualita degli oscillatori RC a bassissime frequenze. *Note Recensioni e Notizie*, *6*, 459 (1957).

The Author comments:

DEAR SIR,—The normal type of parallel-T circuit was considered by myself some years ago as a suitable frequency determining network for a single transistor oscillator. It was then decided to be not suitable since the parallel-T circuit does not 'match' the transistor impedance characteristics. This results in two serious drawbacks: (a) the transistor β required to maintain oscillations is rather high (b) the frequency determining equation is rather complex and involves the transistor parameters. It was for these reasons that the modified parallel-T circuit was developed resulting in a circuit which would operate with low-β transistors and yielding a simple frequency equation[1], namely $\omega_o = 1/RC$. It is suggested that the modified parallel-T circuit is eminently 'designable' and is far more reliable and practical than the circuit analysed by Mr. Francini.

Yours faithfully,

E. T. EMMS,
General Precision Systems Limited,
Aylesbury.

REFERENCE

1. EMMS, E. T. A Novel Single Transistor RC Oscillator. *Electronic Engng.* *32*, 506 (1960).

Short News Items

The winners of the 25-guinea premiums awarded by the radio and electronics industry for technical articles published in 1960 have been announced by the Electronic Engineering Association and the Radio Industry Council, the sponsors of the scheme. Sir Harold Bishop, Director of Engineering, BBC, presented the awards at the Café Royal, London, on 25 April. The 1960 prizewinners (not in order of merit) were:

A. E. Crawford, "Piezo-electric Voltage Transformers" — *Wireless World*, October.

G. L. Grisdale and D. A. Paynter, "A Tropospheric Scatter Link over a 200-mile Path"—*Point-to-Point Telecommunications*, October.

D. L. Swale, "Integrated Electromechanical Design as Applied to Electronic Equipment"—*British Communications and Electronics*, March.

C. M. Cade, "Infra-red Radar Surveillance and Communications"—*British Communications and Electronics*, June-July.

E. N. Rowlands and H. S. Wolff, "The Radio Pill"—*British Communications and Electronics*, August.

P. L. Owen, M. F. Partridge, and T. R. H. Sizer, "The Differential Analyser and its Realization in Digital Form" —*Electronic Engineering*, October.

The panel of judges comprised Professor H. E. M. Barlow, B. C. Brookes, A. H. Cooper, F. Jeffrey, G. Reeves and Dr. R .C. G. Williams, under the chairmanship of H. E. F. Taylor, who succeeded the late Air Marshal Sir Raymund G. Hart. The awards scheme is likely to be extended and revised for 1961.

Professor H. E. M. Barlow, Dean of the Faculty of Engineering, Pender Professor of Electrical Engineering and Director of Laboratories in the University of London, University College has been elected Fellow of the Royal Society. Professor Barlow is distinguished for his work on engineering aspects of microwaves, particularly waveguides and semiconductors.

An interlocking system of technical standardization in the electronics industry is to be set up throughout Europe and it is strongly supported by the British electronic organizations. The agreement means that the 13 countries in the European Economic Community, and in the European Free Trade Association—the 'Six' and the 'Seven'—will work to common standards. The following statement has been issued on behalf of the United Kingdom electronic industry: "As a result of a recent meeting of Western European National Standards Organization it has been agreed that the 13 countries in the Free Trade Association and the European Economic Community should collaborate on an equal footing, with a view to producing common Western European standards. It is proposed that this end should be achieved by developing and promoting the use of internationally agreed characteristics and performance standards from such bodies as I.S.O., I.E.C., C.C.I.T.T., C.C.I.R. and C.E.E."

The Council of the Television Society has awarded the "Electronic Engineering" premium to B. Eastwood, of A.E.I. Ltd. for his paper entitled "Deflexion Techniques for 110° Picture Tubes".

The Council of The Society of Instrument Technology have decided to inaugurate an annual lecture on a general subject. The first President of the Society, Sir George Thomson, M.A., F.R.S., Master of Corpus Christi College, Cambridge, has consented to give his name to this lecture and to deliver the first of the series on Thursday, 19 October, at the Royal Institution. Admission will be by ticket only.

Belling & Lee Limited have been engaged by Sir Alexander Gibb & Partners, consulting engineers, on behalf of the Air Ministry, to assist in the design and implementation of r.f. shielding and interference suppression on the Ballistic Missile Early Warning System project at Fylingdales Moor. The purpose of the shielding is to protect operating personnel from the extremely high r.f. radiated power which will be used and to ensure interference-free conditions of working for varied electronic equipment, including the computers, to be housed there.

The Government have agreed to the siting of a Post Office radio station on Kiln Farm in Stokenchurch, Buckinghamshire. The station will consist of a building about 75ft square and 13ft high, and a radio tower 250ft high with a maximum diameter of 55ft. The station is required by the Post Office primarily for purposes of national defence, but it will also have civil uses.

The Post Office is to co-operate with the U.S. National Aeronautics and Space Administration and the French Centre for Telecommunications Studies in a programme for transatlantic testing of communications satellites. This is jointly announced by the United States, France and the United Kingdom. Ground stations are to be built in England and France for the reception and transmission of telephone, telegraph and television signals across the Atlantic using satellites to be launched by NASA during 1962 and 1963 in Projects RELAY and REBOUND. The stations will be equipped with advanced radio facilities, having extremely accurate tracking and antenna pointing facilities and capable of conducting tests with active and passive satellites at high frequencies and low power. Project RELAY, NASA's low altitude active repeater satellite to be launched in 1962, will weigh less than 100 lb. In addition to equipment for conducting the communications experiments, the space-craft will contain instruments to detect radiation damage and other effects of space conditions on critical components. Project REBOUND is the follow-on of NASA's first passive reflector communication satellite programme, ECHO. It involves placing several rigidized inflated spheres in orbit by using a single launch vehicle. The first launch to orbit three spheres is planned for 1963. RELAY and REBOUND are research and development projects to demonstrate feasibility, basic concepts and technological approaches and to evaluate various systems to be employed in communications satellites. To an extent permitted by orbital and other technical considerations, it will be possible for other countries so desiring to provide the necessary ground facilities to participate in these co-operative experiments. The siting and equipment of the British ground station, and therefore the cost, have not yet been settled, but the location will probably be in the South West.

The Electrical Research Association has announced that James R. Beard, C.B.E., is to be its President for the year 1961-62. Mr. Beard was President of the Institution of Electrical Engineers 1940-41.

The British Electrical and Allied Manufacturers' Association, as one of the special activities of the Association during its fiftieth year of incorporation, is arranging a two-day Export Conference which will be held on 5 to 6 October 1961. The President of the Board of Trade, the Rt. Hon. Reginald Maudling, M.P., has promised to speak to the participants on the first day.

J. Langham Thompson Ltd of Bushey Heath, Herts, have entered into a licensing agreement to manufacture a range of dimensionless strain gauge type transducers designed by Statham Instrument Inc., Los Angeles, California. These transducers are claimed to have high accuracy, long-term stability and insensitivity to temperature changes.

The Electronic Valve and Semi-Conductor Manufacturers' Association (VASCA) has elected Mr. S. S. Eriks, O.B.E. (managing director of Mullard Ltd), as its president and chairman of the Council, and Mr. C. A. W. Harmer, O.B.E. (a director of Pye Ltd), chairman of the Association and chairman of the General Management Committee. Mr. J. Bell (managing director of the M.O. Valve Co. Ltd) has been elected vice-chairman of the British Radio Valve Manufacturers' Association (BVA).

The European Nuclear Energy Agency of the Organization for European Economic Co-operation has arranged with the Atomic Energy Research Establishment at Harwell (United Kingdom) and the *Centre d'Etudes Nucléaires* at Saclay (France) for two international seminars on nuclear energy. Designed for the teaching staffs of universities and higher technical colleges, each seminar will accept about 50 applicants, who will have the opportunity to study the latest advances in nuclear science and techniques, to do certain practical work, and to visit nuclear installations. The Harwell seminar will take place from 10 to 21 July, and that at Saclay from 26 June to 7 July. The cost of both seminars is being borne by the European Nuclear Energy Agency, and participants will be required to pay only travelling and living expenses. Further information may be obtained from the O.E.E.C. European Nuclear Energy Agency, 38 Boulevard Suchet, Paris 16e.

Nineteen member firms of the Scientific Instrument Manufacturers' Association of Great Britain, 20 Queen Anne Street, London, W.1, will exhibit 500 instruments worth £220 000 on the joint SIMA stand at the British Trade Fair, Moscow, 19 May to 4 June.

Closed-circuit television as an aid to teaching was recently demonstrated by High Definition Television Ltd, a company of the Pye Group, in co-operation with the Middlesex Education Committee, the Hayes and Harlington Divisional Executive and the School Governors. Two schools two miles apart—Hayes Grammar School and Barnhill Secondary Modern School—were linked by microwave equipment so that science lessons from the Grammar School could be televised direct to the Secondary Modern School. Two small Pye industrial television cameras were used in the demonstration. One of these was situated directly opposite the teacher and covered his desk and the blackboard. The second camera, on the teacher's extreme right, was used for enlarging small objects and to give close-up views during scientific experiments. A third camera is built into a console with a 16mm film projector in order to provide telecine facilities. At the Barnhill School a large High Definition Television schools receiver with a 27in screen was used. The teacher in the receiving class was provided with a separate monitor screen.

The electronic sections of Armstrong Whitworth Aircraft Ltd and Brush Electrical Engineering Co. Ltd have been linked to form a partnership, known as Armstrong Whitworth/Brush, to manufacture and market advanced electronic and electrical control and intelligence systems. Two contracts have already been received by the new partnership. One is for data link equipment for a secret radar installation, and the other for recording equipment for experiments in the detection of underground nuclear explosions.

An International Symposium on Aero-Space Nuclear Propulsion will be held in Las Vegas, Nevada, 23 to 26 October 1961. This symposium is jointly sponsored by the Institute of Radio Engineers Professional Group on Nuclear Science, the AEC and the NASA. The meeting will be unclassified and include among other topics a review of the ROVER, PLUTO, and ANP programmes. Papers are being requested for presentation at the meeting. Subject matter includes instrumentation, control systems, engine simulation, and engine dynamics aspects of aero-space nuclear propulsion and nuclear auxiliary power fields, as well as radiation and temperature effects on instruments and controls. A rough draft of each paper and a 500-word abstract should be submitted by 1 July 1961 to P. M. Uthe, University of California, Lawrence Radiation Laboratory, Box 808, Livermore, California.

Mr. Richard Melville has been appointed Scientific Attaché to the British Embassy in Paris with the rank of Senior Principal Scientific Officer. He will advise the British Ambassador (Sir P. J. Dixon, G.C.M.G., C.B.) on scientific matters and report on French scientific and technical development in the civil field.

Marconi's Wireless Telegraph Co. Ltd of Chelmsford, Essex, and Wilcox Electric Co Inc. of Kansas City, Missouri, announce the signing of an agreement for collaboration in the field of airborne radio and radar equipment. The agreement covers the full interchange of design, engineering and production information and includes the manufacture and sale by either firm of equipment designed by the other. An agreement has also been signed between Ekco Electronics Ltd and Wilcox Electric Company Inc. whereby the latter company will produce airborne weather radar equipment in the U.S.A. for a period of 10 years. This equipment was originally developed by Ekco Electronics.

The sixteenth Annual Electronics, Instruments and Components Exhibition and Convention organized by the Institution of Electronics is to be held at the Manchester College of Science and Technology from 6 July to 12 July. Particulars of the Exhibition and Convention can be obtained from the secretary, Mr. W. Birtwistle, 78 Shaw Road, Rochdale, Lancs.

Mr. P. A. Fleming, the technical secretary of the British Radio Valve Manufacturers' Association (BVA) and the Electronic Valve and Semi-Conductor Manufacturers' Association (VASCA) attended a conference held recently in Syracuse, New York, at the invitation of the Joint Electron Device Engineering Council of the Electronic Industries Association, the organizers of the conference. Since 1951 there has been considerable exchange of information between the U.S. and U.K. associations to secure alignment of national standards on dimensions and methods of measurement.

A new type of loud-speaking communication system has been developed for the Royal Navy's first nuclear-powered submarine, H.M.S. *Dreadnought*, by the Industrial Supplies Division of Standard Telephones and Cables Limited. In the *Dreadnought* installation there are 64 loud-speaking stations, each of which consists basically of a microphone and pre-amplifier unit, a loudspeaker and a loudspeaker amplifier unit. Stations can be directly coupled in groups of stations by the operation of switches, or connected to the ship's automatic exchange. These switches allow the setting up of a large number of different sized groups which may vary from 2 stations to 60 stations. The amplifiers are fully transistorized units, built to withstand full Admiralty shock and vibration tests. Special features have been incorporated in the automatic gain control circuits so that when there is no speech the gain of the microphone amplifier is very low, whereas that of the loudspeaker amplifier is high. When the operator speaks into his microphone, the gain of the microphone amplifier is increased while that of the loudspeaker amplifier is decreased. This prevents acoustic feedback from the loudspeaker into the microphone.

ELECTRONIC EQUIPMENT

A description, compiled from information supplied by the manufacturers, of new components, accessories and test instruments.

(Voir page 331 pour la traduction en français ; Deutsche Übersetzung Seite 337)

COMPARATOR BRIDGE

(Illustrated below)

Mec-Test Ltd, Henrietta House, Henrietta Place, London, W.1

The Comparatron Limit Bridge type 51 provides a rapid means of testing resistors, capacitors and inductors for accuracy of value to pre-set limits. Two limit dials are set to the required tolerance up to ±25 per cent (in steps of 0·2 per cent) and components can be tested in a fraction of a second.

This instrument is a self-contained mains operated universal impedance bridge operating at a frequency of 1kc/s for the rapid comparison within pre-set limits of resistors, capacitors and inductors of the types and sizes most commonly used in radio and electronic equipment. When manually employed it will test components as fast as they can be applied to the contacts. Indication is made by coloured signal lamps showing

'REJECT HIGH' or 'PASS' or 'REJECT LOW' (and aural indication can be supplied for blind operators). Under these conditions the Comparatron Limit Bridge is as simple to operate as a 'go/no go' gauge.

Inspection of components under automatic production conditions is arranged by connecting a rejecting mechanism to the appropriate relay contacts. The plug-in panel on the front of the instrument allows of rapid changeover from manual test jig to automatic working.

The Comparatron Limit Bridge is immune from stray pick-up and hand capacitance effects, and stable settings are ensured by a null balance at each limit. The bridge source voltage is 1·5V r.m.s. balanced to earth (impedance 0·6Ω).

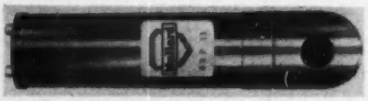
EE 33 751 *for further details*

INFRA-RED PHOTOCELL

(Illustrated above right)

Mullard Ltd, Mullard House, Torrington Place, London, W.C.1

Mullard have developed a new photoconductive cell, the ORP13, which is claimed to have a higher detectivity than any other photocell with infra-red applications yet commercially available in the world. It is intended for applications



involving infra-red spectroscopy and research into the properties of materials.

The cell, which has a sensitivity area of approximately 3mm² of indium antimonide, is attached to its own Dewar flask and is cooled by liquid nitrogen to a temperature of 77°K (−196°C). This cooling system enables very good noise figures to be obtained and its efficiency is such that the cell can be used for 45 minutes without refilling the flask.

The spectral range of the ORP13 is from visible to about 5·4μ, the peak occurring at between 4·5 and 5μ. Its sensitivity to monochromatic radiation is 15mV/μW of incident radiation.

EE 33 752 *for further details*

A.C. MICROVOLTMETER

(Illustrated below)

Marconi Instruments Ltd, St. Albans, Hertfordshire

The a.c. microvoltmeter type TF1375 combines high gain with freedom from hum. Covering the range 5μV to 15V in twelve ranges, it is fully transistored and completely portable, with self-contained battery supply. The frequency range is 50c/s to 1Mc/s with switch-selected l.f. rejection.

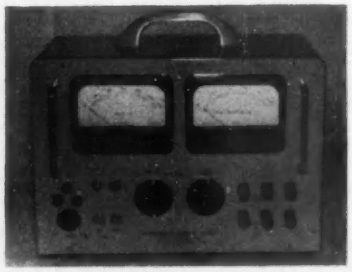
Basically the instrument consists of a frequency-compensated input attenuator with decade steps, and a seven-transistor frequency-compensated amplifier having a voltage gain of approximately ×5 000.

Output from this amplifier is rectified in a full-wave bridge circuit before application to the meter; in addition, the output from the penultimate stage is available at a front-panel outlet.

The 4in meter has an overload-protected movement with clear high-discrimination voltage and decibel scales.

The TF 1375 can be used for a variety of purposes; for example, as an oscilloscope pre-amplifier, as a sensitive measuring-bridge detector, or for field strength and aerial tests. In conjunction with a suitable pick-up loop, measurement may be readily made of leakage flux emanating from mains transformers and electric motors. Input impedance and sensitivity are such that it can be used as a microammeter for detecting currents as low as 10^{-10}A.

EE 33 753 *for further details*



STABILIZED POWER UNIT

(Illustrated above)

Allied Electronics Ltd, 28 Upper Richmond Road, Putney, London, S.W.15

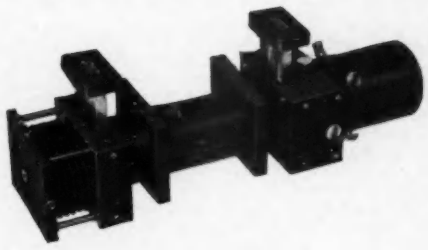
The latest addition to the 'Altron' range of electronically stabilized power supply units is type EV451-A. This is a portable unit measuring 12½in by 11in by 8½in overall and providing fixed and variable d.c. outputs of 200V and 0 to 300V respectively in addition to a heater supply of 6·3V 3A (a.c.).

The variable supply may be adjusted to any voltage in the range 0 to 300V by coarse and fine controls, and will deliver up to 50mA at any voltage between 0 and 250V; the stability of output voltage about the set point is better than ±0·015 per cent for changes in mains supply of ±10 per cent and all current values from no load to full load. The internal resistance of the supply is less than 0·25Ω and the impedance less than 2Ω up to 50kc/s. A voltmeter and an ammeter are permanently connected in the variable supply.

The maximum ripple voltage is 1mV r.m.s. under all conditions. Any current up to 8mA may be drawn from the 200V fixed supply, and the character-

MESUCORA

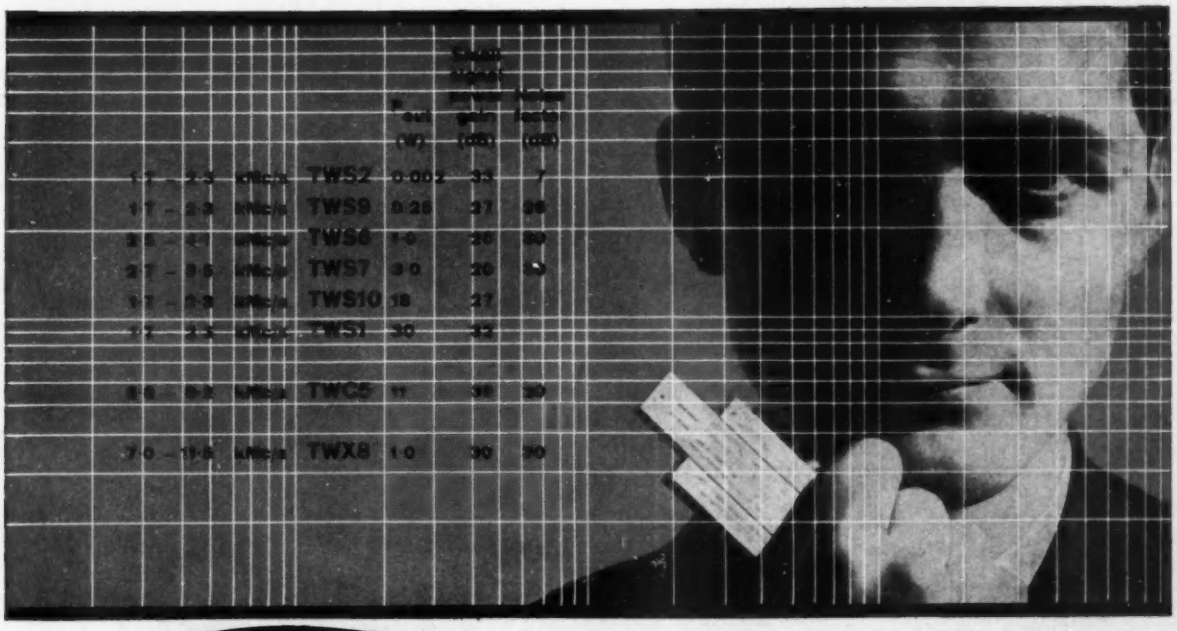
(Measurement, Control, Regulation and Automation) 'Electronic Engineering' will occupy stand AB3-10 at the above exhibition to be held in Paris from 9 to 17 May and visitors will be welcome.



WE CAN GET YOU OUT OF A travelling wave tube PROBLEM

One tube designed to solve many problems is the TWC5. It has an output of 11 watts and a gain of 39 dB. over a frequency range 5.8–8.2 kMc/s. It is readily replaceable in the periodic magnetic circuit. If you have a valve problem simply telephone RIV 3431 and ask for our Technical Information Centre or write to the address below.

* You will find the solution to many valve problems on our stand at the RECMF Exhibition, Earls Court, May 30th–June 2nd. Stand Number 163.



G.E.C.

THE M-O VALVE CO LTD

BROOK GREEN HAMMERSMITH LONDON W6

EE 33 119 *for further details*

NEW TV TUNER HIGH SLOPE VHF TETRODE

EDISWAN MAZDA 30F27

The 30F27 is a frame grid VHF tetrode having a mutual conductance of 15 mA/V at an anode current of 13·5 mA and a screen current of 1·7 mA with variable-mu characteristics to reduce cross-modulation effects at high signal levels.

This tetrode used in the RF stage of a television tuner offers certain advantages over the more conventional double triode cascode arrangement. For instance, the number of circuit components required is smaller, the layout is simpler and for valves having comparable slopes the single cathode type valve can be manufactured more economically.

Normally the noise performance of a tetrode is inferior to that of a triode due to the presence of partition noise arising from the screen current. However the 30F27 has been specially designed to provide a low ratio of screen to anode current to minimise the effect of partition noise while still retaining good screening between control grid and anode. When this is used in conjunction with frame-grid techniques a high slope per milliamp of anode current can be obtained resulting in a high gain RF valve with a noise performance much superior to that of a conventional pentode and equal to that of a double triode cascode amplifier such as the 30L1.

Heater Current (amps)	I_h	0·3
Heater Voltage (volts)	V_h	3·7

TENTATIVE RATINGS AND DATA

Maximum Design Centre Ratings

Anode Dissipation (watts)	$p_{a(max)}$	2·5
Screen Dissipation (watts)	$p_{g2(max)}$	0·4
Anode Voltage (volts)	$V_{a(max)}$	250
Screen Voltage (volts)	$V_{g2(max)}$	230
Heater to Cathode Voltage (volts rms)	$V_{h-k(max)rms}$	90*
Cathode Current (mA)	$I_{k(max)}$	18

* From Cathode to higher potential heater pin.

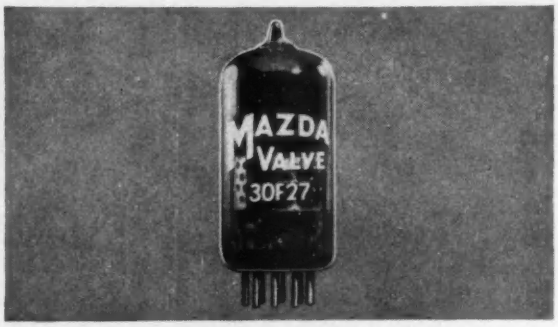
Inter-electrode Capacitances (pF)†

Input Capacitance	c_{in}	6·3
Output Capacitance	c_{out}	1·8
Grid 1 to Anode	c_{g1-a}	0·027
Grid 1 to Grid 2	c_{g1-g2}	2·0
Grid 1 to Cathode	c_{g1-k}	4·0

† Measured in fully shielded socket, without can.

Maximum Dimensions (mm)

Overall Length	56
Seated Height	49
Diameter	22·2



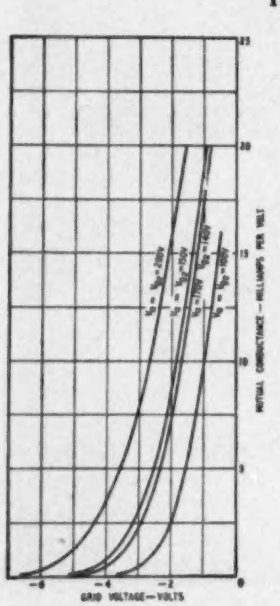
TYPICAL OPERATION

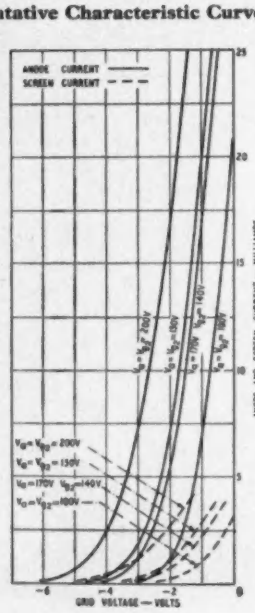
		Cathode Self Bias Circuit	Grid Current Bias Circuit
Supply Voltage (volts)	V_b	200	200
Anode Voltage (volts)	V_a	170	150
Screen Voltage (Initial) (volts)	V_{g2}	140	105
Anode & Screen Common Decoupling Resistor (kΩ)		—	3·3
Anode Decoupling Resistor (kΩ)		2·2	—
Screen Decoupling Resistor (kΩ)		33	33
Cathode Bias Resistor (Ω)	R_k	82	—
Grid Current Bias Resistor (kΩ)	R_{g1}	—	330
Grid Bias Voltage approx. (volts)	V_{g1}	−1·25	—
Anode Current (mA)	I_a	13·5	14
Screen Current (mA)	I_{g2}	1·7	1·4
Mutual Conductance (mA/V)	g_m	15	15·5
Inner Amplification Factor (g_1 to g_2)	μ_{g1-g2}	60	—
Equivalent Grid Noise Resistance (Ω)	R_{eq}	450	—
Input Loss at 50 Mc/s (kΩ)	$r_{g1-k(w)}$	6·8¶	—
Input Capacity Working (pF)	$c_{in(w)}$	10·3¶§	—
Change in Input Capacity produced by biasing valve to cut-off (pF)	$\triangle c_{in(w)}$	2·9¶	—

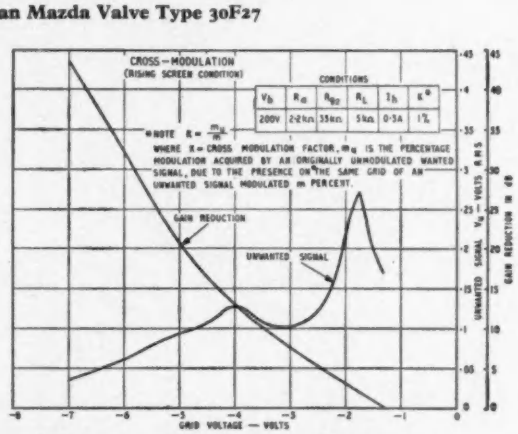
¶ Measured at 50 Mc/s with the three cathodes strapped and taken directly to earth.

§ Inter-electrode capacity with holder capacity balanced out.

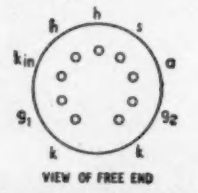
Tentative Characteristic Curves of Ediswan Mazda Valve Type 30F27

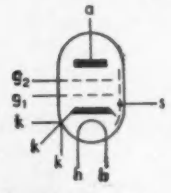






Base: B9A (Noval) **Mounting Position**: Unrestricted





EDISWAN
MAZDA

Associated Electrical Industries Ltd
Radio and Electronic Components Division
Technical Service Department
155 Charing Cross Road, London, W.C.2
Tel: GERrard 9797. Grams: Sieswan, Westcent, London
TA 15/101/5154

istics of the supply are otherwise as for the variable supply. The two d.c. supplies are brought out to three terminals, the variable supply being positive, and the fixed supply negative, with respect to the common terminal: both supplies are isolated from earth, hence the unit may be used to produce a low current (0 to 8mA) supply of 0 to ±500V.

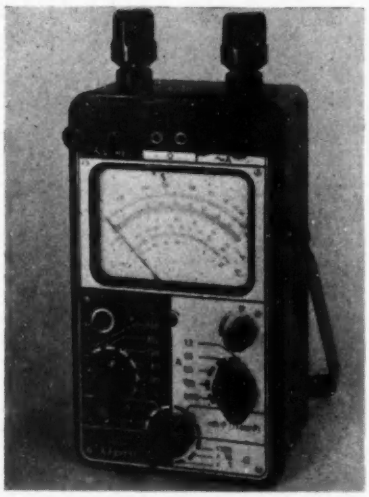
EE 33 754 *for further details*

MULTI-RANGE METER

(Illustrated below)

Distributed by: Aveley Electric Ltd, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex

The Gossen meter type UPHI is a robust multi-range instrument designed for the measurement of alternating voltage, real and reactive current, power factor, frequency, resistance, apparent phase-angle and reactive powers.



The versatility and robust construction of the UPHI, combined with a mirrored scale, make it a useful and portable measuring instrument for use in the 40c/s to 4kc/s range.

The full scale readings provided by the UPHI are 12 to 600V, 60mA to 120A, 1Ω to 100kΩ multi-range ±90° (cos ϕ sin ϕ) at 400c/s and 4kc/s.

The unit has strong moving-coil movement of high quality, with spring-loaded jewelled bearings. An internal 1·5V battery is used as a power supply source for resistance measurements, a rotary potentiometer being used for zero setting.

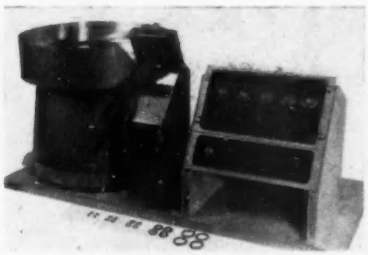
EE 33 755 *for further details*

BATCH COUNTERS

(Illustrated above right)

Pentechnique Ltd, Imperial Lane, Cheltenham, Gloucestershire

Compact batch counters, with 2, 3, 4 or 5 Dekatron tubes, which can be supplied with many modifications to suit particular applications are the latest developments in the Pentechnique Limited range of counting units. Capable of batching numbers up to 99 999 at rates up to 5 000 per second, the units



can be fed from photo-electric or magnetic pick-ups. The lower section of the units can have controls and circuits specifically designed for the type of feed equipment to be used and the batch output signal can be in the form of relay contact closure or electrical signal.

The illustration shows a 5-Dekatron batch counter used with a vibratory bowl feeder and photo-electric pick-up to count pre-selected quantities of rubber 'O' rings. Two simple adjustments cater for 15 different sizes from 7/32in o.d. to 15/16in o.d. All controls, including those for the bowl feeder, are grouped on the lower panel of the batch counter and special circuits ensure foolproof operation. The 'start' button resets the Dekatrons to zero to initiate the process and if, for any reason, the resetting is faulty the bowl feeder will not be energized. The operator is thus relieved from the necessity to check that the resetting is correct. If, during a count, it is required to stop the bowl feeder the 'stop' button can be pressed—subsequent operation of the 'start' button will not reset the Dekatrons but will allow the count to continue from where it left off.

A variety of magnetic and photo-electric pick-ups can be supplied to detect a wide range of components. Mounting arrangements for the pick-ups and adaptations of bowl feeders can be undertaken if required.

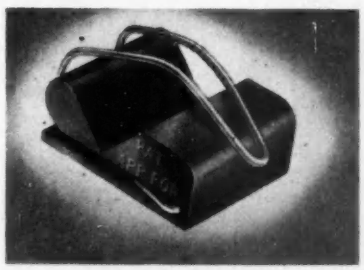
EE 33 756 *for further details*

SEMICONDUCTOR RETAINERS

(Illustrated below)

Rendar Instruments Ltd, Victoria Road, Burgess Hill, Sussex

These retainers have been designed to firmly anchor transistors between 3/16 and ¼in diameter. The base is moulded in polypropylene and clamping is carried out by a hardened beryllium copper spring. The retainer can be fixed to a panel by one 8 B.A. screw and a moulded pin prevents twisting.



EE 33 757 *for further details*

HIGH IMPEDANCE VOLTMETER

(Illustrated below)

Distributed by: Scientific Furnishings Ltd, Poynton, Cheshire

The Halex model 301E Electrosensor Voltmeter is a sensitive precision unity gain follower-amplifier with a d.c. following accuracy of 0·001 per cent and a current sensitivity of 10^{-18}A (60 electrons/sec). The effective input resistance is greater than $10^{-17}\Omega$ and the input capacitance less than 0·01pF so that the response time is negligible. Low and high impedance output terminals are provided of less than 0·2Ω and 500Ω respectively.

Conveniently located shieldings on the input terminal permit instrumentation arrangements for extremely low energy work without the need for large cumber-

some shieldhoods or shielded rooms, and without causing long time-constants to upset the readings.

The performance of the Electrosensor Voltmeter is the result of a design technique known as 'relativistic coupling' developed in the U.S.A. by Halex Incorporated. Eight stages of amplification are used including a floating electrometer amplifier but without either vibrators or choppers.

The system consists of three precision unity gain amplifiers completely surrounded by three distinct screens, the earth for the innermost amplifiers serving as the screen for the succeeding amplifiers. Each of the three screens is connected to one of the three Teflon insulated guard shields concentrically located around the centre input conductor together with an external earth shield. The three guard shields are driven from the amplifiers in the instrument at voltages very nearly identical to the input signal on the centre conductor. The effect of this system is to raise the effective input impedance above that of the Teflon insulation and even above the free space surrounding the

instrument. The multiple shielding also prevents stray pick-up.

An output meter is built in to provide a display accuracy of 1 per cent. A switch selects eleven calibrated ranges with full scale values from ±1V up to ±250V d.c. or 500V peak-to-peak for low frequency a.c. Frequencies up to 1kc/s can be accepted at low amplitudes from a low impedance source. The meter switching does not affect the input resistance, the output from the terminals or the gain of the individual amplifiers. After warming up, the drift is less than 0·001 per cent of full scale voltage.

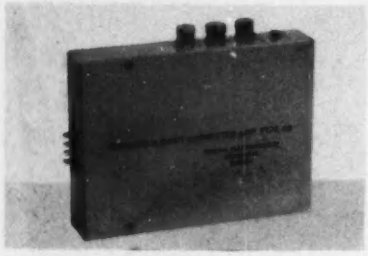
EE 33 758 *for further details*

TRANSISTORIZED D.C. AMPLIFIER

(Illustrated below)

Fenlow Electronics Ltd, Springfield Lane, Weybridge, Surrey

This completely transistorized chopper stabilized d.c. amplifier is intended for use in process control, analogue computing and general amplifier applications.



It is a high gain amplifier incorporating an auxiliary drift correction channel which makes use of a chopper transistor. The chopper drive waveform is obtained from a multivibrator which is incorporated in the amplifier case.

The drift is of the order of 200μV, the noise less than 100μV and the open-loop bandwidth 1kc/s.

EE 33 759 *for further details*

SOUND LEVEL METER

(Illustrated above right)

Distributed by: B & K Laboratories, 4 Tilney Street, Park Lane, London, W.1

The Brüel & Kjær precision sound level meter type 2203 is transistorized, portable and battery-operated and is built to fully fulfil the proposed international IEC standards for precisioon sound level meters.

Equipped with a precision capacitance microphone (B & K type 4131) the instrument gives a direct scale reading from 22 to 134dB to an accuracy of ±1dB and the linear frequency characteristic ranges from 20c/s to 15kc/s. An overall amplification of 110dB gives full deflexion on the meter for an input voltage of 10μV, and by applying extensive negative feedback throughout, stable operation of the amplifier is ensured. A built-in stabilized control generator gives a ready check on the amplification. Between the first and second stages of the

amplifier the three IEC weighting networks for precision sound level meters are included. The rectifier circuit for the meter is of the quasi-r.m.s. type to fulfil the IEC standard requirements.

The meter can be rapidly converted into a frequency analyser by the connexion of external 1/3 and 1/1 octave filters, and when a permanent record of the measurements undertaken is required, a level recorder can be connected to its output. By substituting the microphone cartridge with an adaptor (input adaptor JJ2612) it can be converted to a voltage and vibration amplifier, and by connecting an accelerometer to the input, vibration measurements can readily be made.

To facilitate the taking of measurements in dim and badly lit places the meter scale can be lit, and when in operation an intermittent pilot light periodically flashes, indicating that the power supply is on. The instrument can be supplied with a solid leather carrying case.

EE 33 760 *for further details*

VALVE-VOLTMETER

(Illustrated below)

Taylor Electrical Instruments Ltd, Montrose Avenue, Slough, Buckinghamshire

The model 172A is a general purpose valve-voltmeter of compact dimensions and good stability. It has an input impedance of 11MΩ on d.c. and between

830kΩ and 1·5MΩ on the a.c. ranges. In conjunction with a crystal probe the meter can be used at frequencies of over 200Mc/s.

The calibrated ranges are: 0 to 1·5kV d.c. in seven ranges; 0 to 1·5kV a.c., r.m.s. in seven ranges; 0 to 4·2kV a.c., peak-to-peak in seven ranges and 0 to 100MΩ in seven ranges. D.C. readings up to 30kV can be made by use of a special probe.

A centre-zero setting and a polarity reversing switch are incorporated.

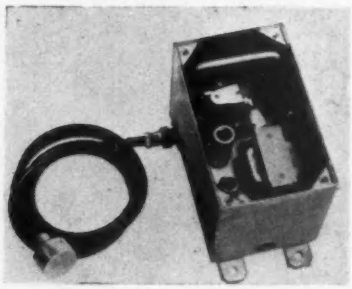
EE 33 761 *for further details*

PROXIMITY SWITCH

(Illustrated below)

The Donovan Electrical Co. Ltd, Granville Street, Birmingham 1

This proximity switch is designed to take the place of normal limit switches in particularly arduous situations, or where it is not convenient to make physical contact with a mechanically operated limit switch. The detector head is completely sealed from oil, suds, etc.,



and contains no moving parts. Since there is no iron core or permanent magnet in the head, ferrous dust or swarf are not attracted.

A substantially flat metal surface of sufficient area, say 1 or 2in², coming within approximately ¼in of the flat face of the head causes a relay to operate in the control unit. The repetitive accuracy of operation depends to some extent on the method of application, but it is normally of the order of 0·020in. Provided that it presents sufficient flat surface to the head, any type or thickness of metal is detected, but swarf or metal dust normally have no effect since the particles are too small to be detected. The normal head is 1½in in diameter and this is coupled to the control unit by 6ft of coaxial cable, The control unit is contained in a sheet steel box measuring 7in by 6in by 4½in.

Wide variations of supply voltage from the nominal value of 230 or 400V are permissible. The normal power consumption of the control unit is 6W.

Special heads for tool breakage detection, and special control units for use with static switching systems can be supplied. The proximity switch operates on an inductive coupling principle rather than by capacitance, so that it is not affected by stray pick-up.

EE 33 762 *for further details*

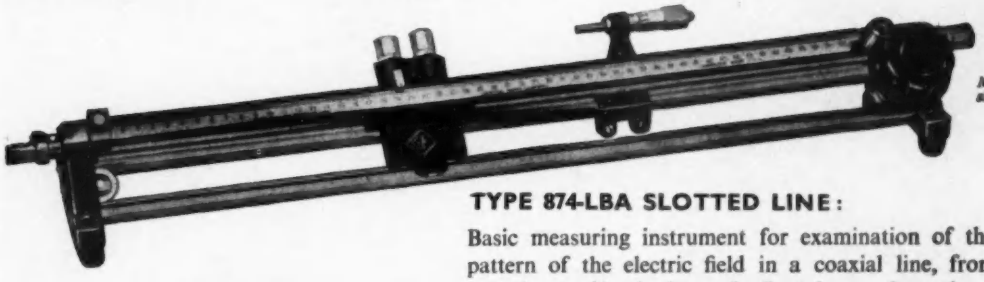
EE 33 120 *for further details*

'GENERAL RADIO'

V.H.F. – U.H.F. MEASURING EQUIPMENT

With basic measuring instruments, such as the Slotted Line or Admittance Meter, generators, detectors, and a wide range of inter-related coaxial elements, all linked through the ingenious Type 874 connector, 'GENERAL RADIO' offer the scientist and engineer a 50-ohm VHF-UHF measuring system that is

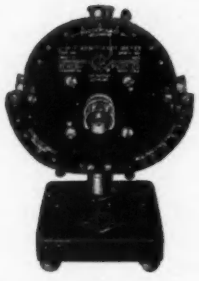
Complete · Integrated · Accurate · Versatile



Micrometer Vernier shown attached.

TYPE 874-LBA SLOTTED LINE:

Basic measuring instrument for examination of the standing-wave-pattern of the electric field in a coaxial line, from which VSWR, impedance of load, phase of reflected wave, losses in attached elements, degree of mis-match between line and load, etc. can be determined. Accurate and straightforward in use. Frequency range 300-5000 Mc/s (with some loss in accuracy: 150-7000 Mc/s). Also available: Type 874-LV Micrometer Vernier (for measurement of high VSWR). Type 874-MD Motor Drive for oscillographic display of standing-wave pattern.



TYPE 1602-B ADMITTANCE METER:

A compact and versatile instrument, accurate and rapid in use, for determining the components of an unknown admittance in the VHF-UHF range. Scales read directly in conductance and susceptance, *independent of frequency*. With unknown connected through quarter-wavelength line, scales read in resistance and reactance. Can be used for measurement of VSWR and reflection coefficient, matching or comparison of impedances, and measurements on balanced line circuits (with the Type 874-UB 'Balun'). Frequency range 41-1500 Mc/s. (Down to 10 Mc/s, with correction). Includes conductance and susceptance standards.

Write for complete information.

THE GR SYSTEM

Keystone of the entire system is the unique Type 874 coaxial connector, fitted to all elements (see illustration below); this low-loss connector, any two of which, *although identical*, can be plugged together gives the system versatility and ease in setting-up for any measurement, and is characteristic of G-R's clear-sighted engineering philosophy. Low-loss adaptors are obtainable to link up with other systems.

Around this connector G-R have developed a wide range of coaxial elements :- lines, stubs, filters, attenuators, capacitors, inductors, insertion units, ells, tees, terminations, etc., of excellent electrical characteristics. These coaxial elements, together with generators, measuring gear, detectors, 'Balun', and other instruments form a complete and integrated line of high-frequency measuring equipment, designed for highest accuracy, dependability and convenience in use ... in keeping with the G-R tradition of supplying only the finest in laboratory equipment.

Identical Type 874 connectors.

Claude Lyons Ltd.

Sole U.K. representatives of the General Radio Company, U.S.A.

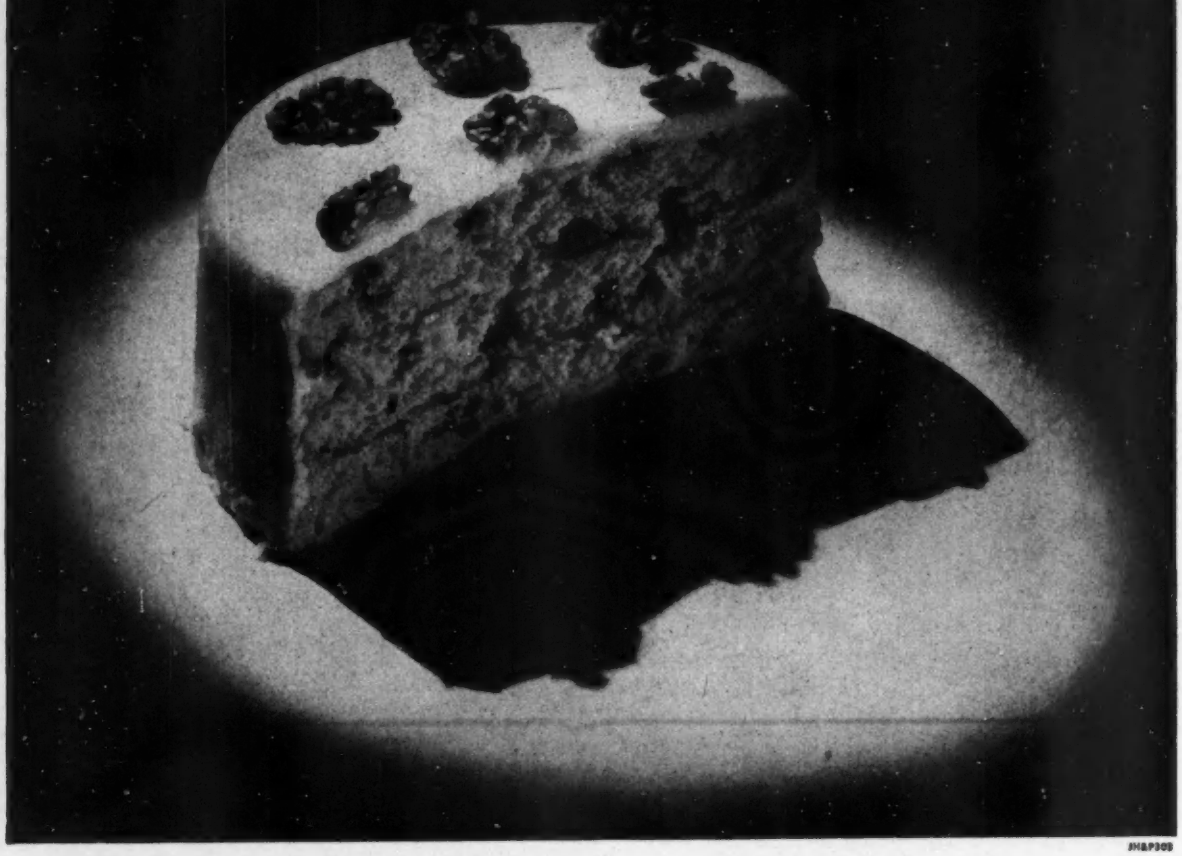
Valley Works · Hoddesdon · Herts · Tel: Hoddesdon 4541-6

and 76 Old Hall Street · Liverpool 3 · Tel : CENtral 4641-2

CL6/1C

ORDERED ABROAD

or It's a Piece of Cake



JHAP309

A Gripping Contemporary Drama

Sell or sink! At a time when exports mean so much to the nation, we reflect with some pride on our own achievement. *Almost half our production goes overseas.* By any standard of judgement, that's a pretty hefty slice of the cake.

But, we feel bound to add, we *ought* to be able to export such a high proportion. We have our equipments to thank for this. With a range as good as ours, the normally difficult business of exporting becomes, quite frankly, *a piece of cake.*

More seriously, BCC design, engineer, instal and service complete communications systems. Our Advisory Service would be glad to have the opportunity of helping to solve *your* problems, in the UK or anywhere else.

BRITISH COMMUNICATIONS CORPORATION LIMITED

HIGH WYCOMBE BUCKS.
Grams: BeeCeeCee High Wycombe

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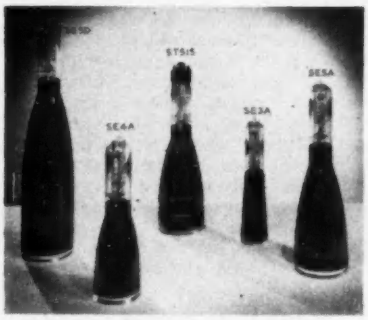
And at Wembley



INSTRUMENT CATHODE-RAY TUBES

(Illustrated above)

Sylvania-Thorn Colour Television Laboratories Ltd, Great Cambridge Road, Enfield Middlesex

A new cathode-ray tube, specially designed for wide bandwidth and high speed oscillography, is now being produced by Sylvania-Thorn Colour Television Laboratories Limited.

The new tube—the SE5D—is a 5in precision high sensitivity helical post deflexion acceleration cathode-ray tube which scans 10cm in the X direction and has a Y sensitivity of 3·5V/cm and an X sensitivity of 14V/cm, at a final anode potential of 10kV. P.D.A. ratio is 12.

Together with the SE5D, four other new tubes are being introduced by Sylvania-Thorn.

The SE5E is identical in appearance to the SE5D but has a scanning area of 6cm × 10cm and a Y sensitivity of 5·5V/cm.

The SE4A and SE4B are both 4in tubes with scanning area of 5cm × 8cm operating at a final voltage 8kV and 4kV respectively. On the SE4A the X sensitivity is 48V/cm and the Y sensitivity 15V/cm, on the SE4B the sensitivities are 25V/cm. Both tubes have a post deflexion acceleration ratio of 4.

The SE3A is a 3in tube with a scanning area of 5cm × 6cm. The X sensitivity is 27V/cm and the Y sensitivity 7V/cm. Final voltage is 4kV.

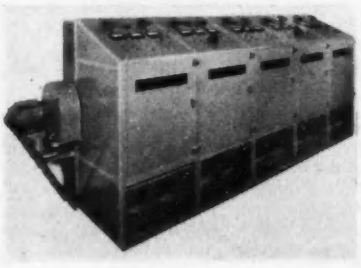
EE 33 763 *for further details*

TRANSISTOR AGEING EQUIPMENT

(Illustrated below)

P.T.S. Electronics Ltd, 96 Horsenden Lane, Greenford, Middlesex

This equipment is divided into five separate ovens which are heated and thermostatically controlled at 45°C ± 2°. Each oven contains slide rails for holding transistor loading cards and each oven holds four cards giving a capacity of 4 000 transistors per oven.



Air circulation is provided by a 1 000ft³/min fan which draws air via ducting through each oven.

Five twin power supplies in the base of the equipment provide 0 to 16V at 100A for supply to the transistors.

EE 33 764 *for further details*

A.F. POWER AMPLIFIER

Goodmans Industries Ltd, Axiom Works, Lancelot Road, Wembley, Middlesex

The PASVA is a 5W (continuous rating) power amplifier covering the frequency range 5c/s to 20kc/s (±1dB) and is primarily intended for driving vibration generators.

The circuit consists of a double triode, operating as an amplifier and phase-splitter, driving a pair of EL84 valves working in push-pull under ultra-linear conditions. Overall negative feedback is taken from the secondary of the output transformer to the cathode of the first valve. Negative feedback on the mid-band is 29dB falling to 26dB at 20kc/s and 22dB at 5c/s.

The total distortion is less than 0·5 per cent between 50c/s and 10kc/s at 5W.

EE 33 765 *for further details*

DOUBLE-BEAM OSCILLOSCOPE

(Illustrated above right)

Solartron Laboratory Instruments Ltd, Cox Lane, Chessington, Surrey

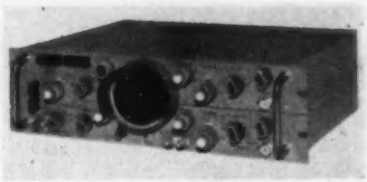
The model CD1016 is a compact double-beam oscilloscope intended for rack mounting.

It has two identical Y amplifiers with a bandwidth of d.c. to 5Mc/s and a rise-time of approximately 70mμsec. Nine calibrated sensitivity ranges cover from 100mV/cm to 50V/cm with ±5 per cent accuracy. In addition a fine control gives continuous coverage up to approximately 100V/cm. The integral a.c. pre-amplifier preceding Y_2 gives six additional sensitivity ranges with a maximum sensitivity of 1mV/cm.

The input impedance is 1MΩ and 30pF. Inputs may be 'floated' up to 500V relative to chassis for displaying signals isolated from earth.

The time-base covers 1cm/μsec to 2cm/sec in eighteen calibrated ranges, in 1-2-5 sequence with ±5 per cent measuring accuracy. A fine control with a calibration position gives continuous coverage to 1cm/sec. The maximum sweep speed of 5cm/μsec may be obtained by using X expansion. The oscilloscope may be triggered internally or externally. 'Level' and 'stability' controls permit accurate and reliable triggering at a selected point on the displayed waveform.

A 'bootstrap' type time-base is employed giving a linearity better than 1 per cent. The time-base waveform (10V peak-to-peak) is available at a socket on the front panel.



The X amplifier (bandwidth d.c. to 750kc/s) has a continuously variable sensitivity from 0·15V/cm to 1·5V/cm. Direct access to this amplifier is available for external signals.

A 30V 'bright-up' pulse derived from a separate bistable circuit, d.c. coupled to the cathode-ray tube, gives bright displays at all sweep speeds. Provision is also made for external brightness modulation.

A square wave of 0·5V peak-to-peak, at mains frequency, is available for calibration of the time-base and Y sensitivity.

Stabilized e.h.t. enables calibration accuracy to be maintained regardless of brightness levels. A 3½in diameter double gun c.r.t. type 3AZP31 is used.

EE 33 766 *for further details*

NEUTRON GENERATOR

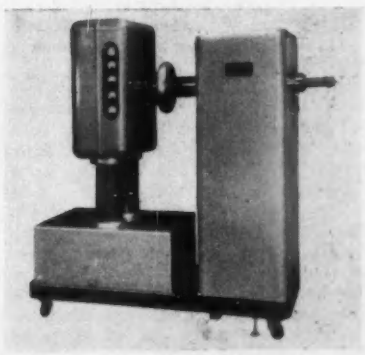
(Illustrated below)

20th Century Electronics Ltd, Centronics Works, King Henry's Drive, New Addington, Croydon, Surrey

This instrument has been designed to provide a source of neutrons of variable intensity and energy for use in the laboratory. The basic features are: high neutron output, experimental flexibility and continuous or pulsed operation.

The instrument employs a D.T. reaction to produce 14MeV neutrons. The deuterium ions are accelerated on to a tritium target, and the neutron output under continuous operation is of the order of 10^{10} neutrons per second. Fast neutrons can be moderated to produce thermal neutrons. The unit is continuously pumped and has an accelerating potential of 150kV.

In addition to this application as a neutron generator the instrument can be quickly adapted to provide accelerated ion beams of deutrons or protons for other nuclear physics applications.



EE 33 767 *for further details*

PRECISION POTENTIOMETER

(Illustrated below)

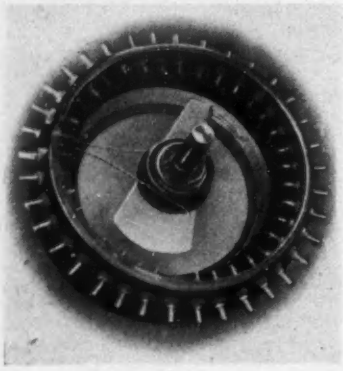
Miles Electronics Ltd, Shoreham Airport, Sussex

This precision potentiometer has an outside diameter of 2 5/32in and a depth of 1in and, although of small dimensions, it is robustly constructed and will operate over a long period without loss of accuracy.

Up to 33 taps can be fitted in addition to the normal end connexions. Tap connexions are made to a single turn of wire and there is thus no short-circuiting of adjacent turns on the resistance element.

The potentiometers have the low starting torque of 5g.cm for resistance values above 10kΩ and 7g.cm below 10kΩ.

Up to 10 units can be supplied ganged together and each gang adds only 0·781in to the length of the assembly.



EE 33 768 *for further details*

PHOTOMULTIPLIER TUBE

(Illustrated above right)

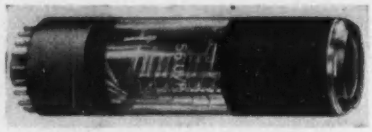
Mullard Ltd, Mullard House, Torrington Place, London, W.C.1

Early last year Mullard introduced the 56AVP, a high definition photomultiplier tube with a peak response at 4 200Å, designed specifically for use with scintillation counters requiring very high time resolution.

They have now announced a development of this tube fitted with a quartz end-window, for use with gas scintillation counters. The new type, 56UVP, is closely similar to the 56AVP, but its spectral response has been extended well into the ultra-violet region and it has a useful response down to 2 300Å, with a peak at 4 000Å.

For high definition work very small electron transit time differences are essential and in the 56UVP they have been kept down to 2·0mμsec at half-pulse height, with a rise-time of the same duration.

This substantial reduction of transit time differences is due to the specially designed input electron-optical system in which the photo-cathode is curved so that the path lengths to the first multiplier stage are approximately equal for electrons leaving any part of its useful area. In fact, the transit time difference between electrons arriving at the first



dynode from the periphery of the photocathode and those arriving from the centre is only 0·3mμsec.

Uniformity of transit times through the 14 multiplier stages is maintained by careful shaping of the dynodes, and by the additional focusing electrodes situated between each multiplier stage, which progressively narrow the electron beam from stage-to-stage despite the rapid growth in the number of electrons.

EE 33 769 *for further details*

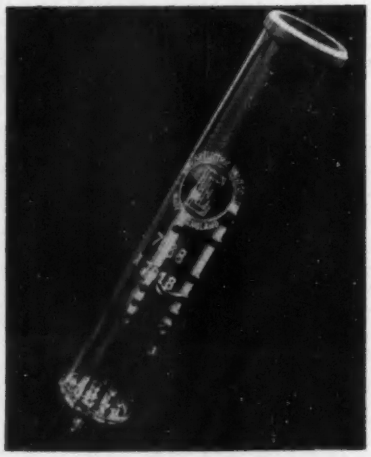
VIDICON PICK-UP TUBE

(Illustrated below)

English Electric Valve Co. Ltd, Chelmsford, Essex

The 7038 Vidicon television pick-up tube has been introduced by the English Electric Valve Co. Ltd to meet the increasing diversity of vidicon applications. This tube is sufficiently comprehensive in design for it to be used in film scanning, studio broadcasting and industrial applications where several specialized tubes have been used previously. Its small size and simplicity facilitate the design and operation of camera and associated equipment which are extremely compact when compared with that required for more complicated types of pick-up tube. This feature is of particular value in the three tube colour camera and in industrial cameras where small overall dimensions are a requirement.

The 7038 has a resolution capability of approximately 600 lines in the centre of the faceplate. A uniform photo-conductive layer is used as the light sensitive element and this is characterized by a virtually panchromatic response which gives faithful reproduction of flesh tints and provides a picture similar to other pick-up tubes. The 7038 has a sensitivity which permits live pick-up from scenes with 100 to 200ft-candles of incident illumination, using a lens aperture *f*/2·8



to *f*/4·0. For pictures of broadcast quality a faceplate illumination of 6 to 15ft-candles in the highlights is recommended for live scene pick-up and 100ft-candles for film scanning. Under these operational conditions smearing is negligible and uniformity of the picture is to the highest standards. For industrial applications this highly sensitive tube may be used wih a minimum of 2ft-candles faceplate illumination with only a slight deterioration in other parameters.

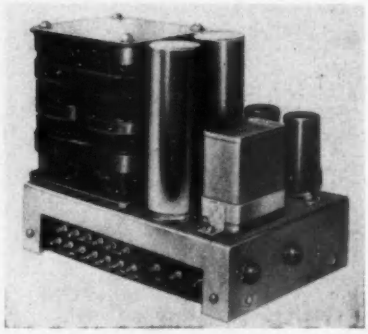
EE 33 770 *for further details*

STABILIZED POWER UNITS

(Illustrated below)

Fraser Speller Transformers Ltd, Sydenham Road, Sydenham, London, S.E.26

These units are suitable for bench use or for building into other equipment. The circuit is of the chokeless type and electrolytic capacitors are used which



results in a compact unit of comparatively low weight. Standard units are available with output voltages of ±150, 200, 250 and 300V at 0 to 100mA and non-standard voltages are available to order. Two 6·3V, 3A a.c. outputs are also provided. The stability of the output voltage is of the order of 0·06 per cent and the r.m.s. ripple less than 2mV. The effective source resistance is less than 0·1Ω and the output impedance less than 2Ω at all frequencies.

EE 33 771 *for further details*

TRANSISTORIZED CHOPPER-MODULATOR

(Illustrated page 329)

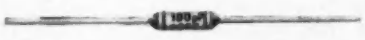
Telephone Manufacturing Co. Ltd, Martell Road, West Dulwich, London, S.E.21

Model SM 10 is a small, highly stable, silicon transistorized chopper designed for low level d.c. chopping. Of the directly coupled type, it offers designers a simple form of clamp-type chopper. It has a built-in wave shaping circuit, will operate from any 6V sinusoidal or square-wave supply from 40c/s to 1kc/s and will switch a range of chopping voltages from 1μV to 250mV.

Carefully selected and matched components are used to give a low drift and practically everlasting performance. Since all the components are encapsulated within an aluminium can the unit is virtually immune from vibration and shock effects. Unlike mechanical choppers it has no moving parts to suffer wear, or

EE 33 122 *for further details*

Where performance and physical size are at a premium specify SUFLEX plastic dielectric capacitors

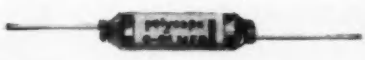


POLYSTYRENE

Range 4.7pf. to 0.5mfd. in values at 125v., 350v. and 500v. working in 20%, 10%, 5% and 2½% tolerance (± ½pf. minimum).

Max. temp. 80°C. P.F.0.0005 Stability 0.5%.

Main feature: Optimum Dielectric Properties



POLYESTER

Range 0.001mfd. to 0.1mfd. at 350v. working in 20% and 10% tolerance.

Max. temp. 100°C. P.F.0.01. Stability 5%.

Main feature: New high order of Reliability

POLYCARBONATE

Range 100pf. to .01mfd. at 125v. and 350v. working in 20%, 10% and 5% tolerance (± 5pf. minimum).

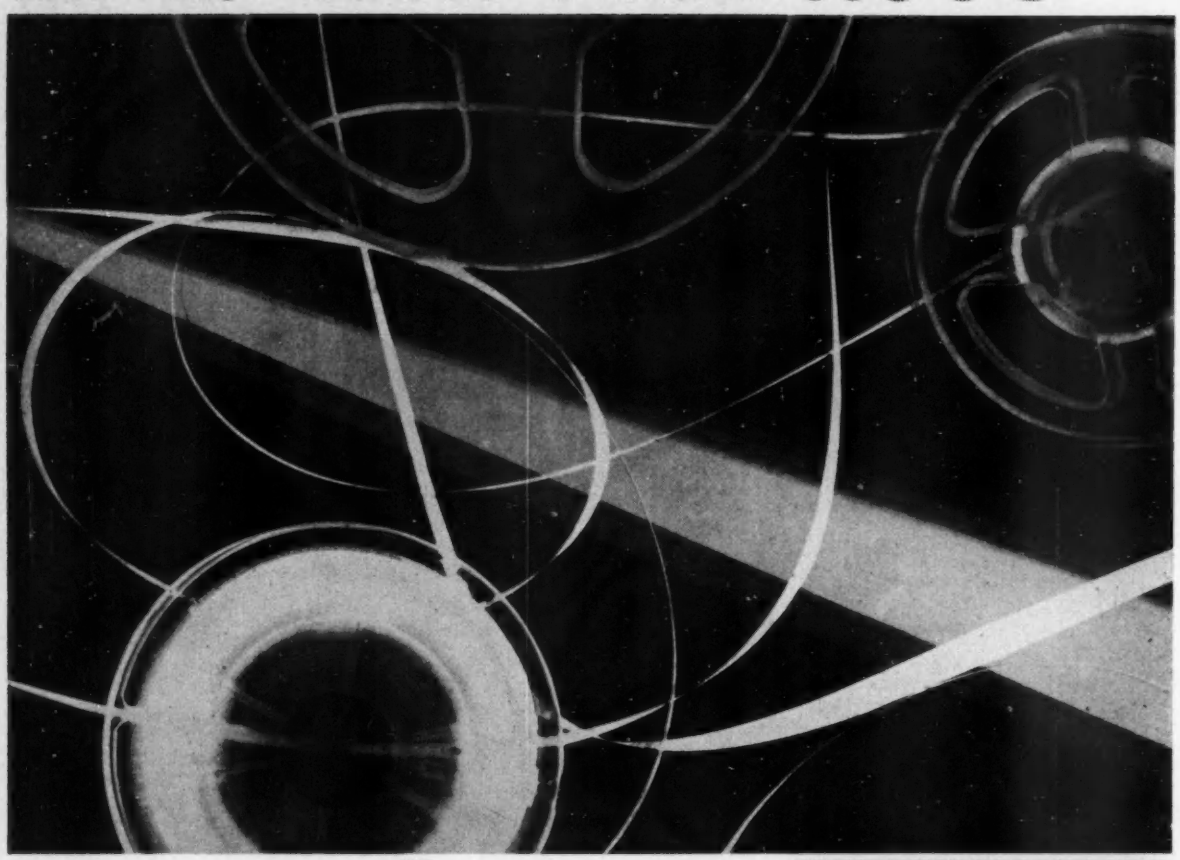
Max. temp. 125°C. P.F.0.003. Stability 5%.

Main feature: High Operating Temperature

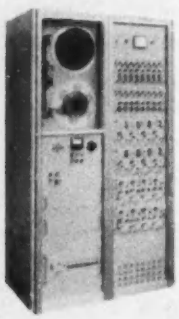
SUFLEX LTD. 54 UXBRIDGE ROAD, EALING, LONDON, W.5

EE 33 123 *for further details*

If it accelerates



record it on Epsylon



6 speed multi-channel recorder

● **If it is, for example, a rocket going up, an aircraft flying, a vehicle going along, or a machine part going back and forth or round and round—whatever its speed, rate of acceleration, direction—Epsylon recorders offer you the most advanced recording facilities: up to 16 channels per inch; wide frequency range from DC; capacity 5,000 ft.; a range of tape speeds up to 150 ins./sec.; endless loop; remote control; recording and replaying at different speeds; fixed and mobile models. Epsylon instruments record physical conditions, digits and sound, and can play a key part in a variety of applications, ranging from research to prospecting; from electronic computers to music in aircraft. May we send you full details?**

EPSYLON INDUSTRIES LTD Faggs Road, Feltham, Middlesex, England. Telephone: Feltham 5091

A member of the Stone-Platt Group

contacts to become contaminated and it never needs adjustment. Moreover, it is highly stable over a wide temperature range.

EE 33 772 *for further details*

MINIATURE INTEGRATING GYRO

(Illustrated below)

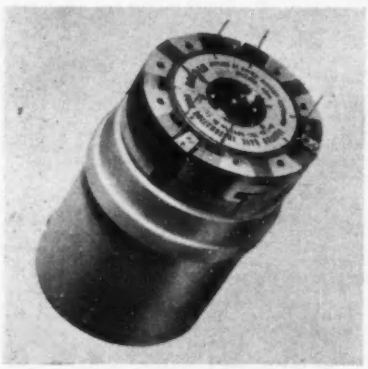
Ketay Ltd, Eddes House, Eastern Avenue West, Romford, Essex

Introduced recently by the Norden Division of United Aircraft Corporation and now available in the U.K. through Ketay Limited, is a new miniature integrating gyro, type RI-203.

Applications for this precision gyro include inertial navigation and guidance for missiles and aircraft, stabilization of shipboard devices and many others demanding dynamic angular measurement.

Features of the new gyro include low drift rate—it has a random drift of less than 0·02°/h, excellent day-to-day stability —0·10°/h without trimming—and the unusually long life of 3 000 hours. The low drift has been achieved with a spin motor turning at only 12 000 rev/min—a speed which contributes substantially to the unit's long life.

Only 3·1in long by 2in in diameter, this guidance gyro, including heater and shields, weighs one pound.



EE 33 773 *for further details*

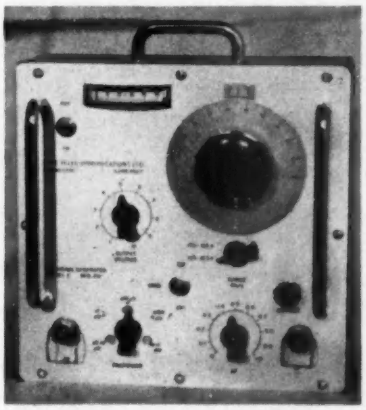
V.H.F. SIGNAL GENERATOR

(Illustrated below)

R.E.E. Telecommunications Ltd, 15a Market Square, Crewkerne, Somerset

This portable signal generator is fully transistorized and has good frequency stability and low leakage, thus catering for the high sensitivities and close channel spacing of modern v.h.f. receivers.

The frequency range covered is 115 to 135Mc/s and the output voltage 0·1μV to 10mV into 75Ω. The r.f. leakage is less than 0·2μV and the frequency drift



less than 5kc/s during a 10min period. The calibration accuracy is 0·2 per cent.

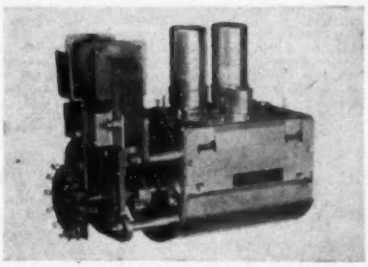
The generator is powered by internal mercury cells.

EE 33 774 *for further details*

MOTORIZED TELEVISION TURRET

(Illustrated below)

The Plessey Co. Ltd, Vicarage Lane, Ilford, Essex



We regret that in the description of this unit on page 254 of our April issue an incorrect illustration was shown. The correct illustration is shown above. The illustration shown in our April issue was a miniature i.f. transformer manufactured by The Wireless Telephone Co. Ltd, who are associates of the Plessey Co. Ltd.

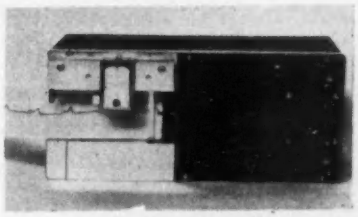
EE 33 775 *for further details*

PORTABLE ELECTROCARDIOGRAPH

(Illustrated above right)

New Electronic Products Ltd, 360 Kennington Road, London, S.E. 11

This miniature portable electrocardiograph measures only 9in by 4in by 4in and weighs 9 lb complete in its leather carrying case. The unit, which employs transistors and printed circuits, is powered by internal rechargeable batteries.



The record can be seen as it is recorded and standard features are incorporated, such as full lead selection and 1mV/cm standardization with 'divide by two' switch.

The chart is 50ft long and 40mm wide and speeds of 50mm/sec, 25mm/sec and 5mm/sec are provided. The recording system is of the hot stylus type and a microswitch varies the stylus heat in conjunction with speed selection.

The input impedance is better than 1MΩ and the frequency response within ±3dB from d.c. to 70c/s.

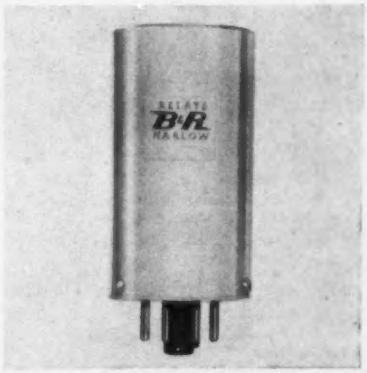
EE 33 776 *for further details*

DRY REED RELAYS

(Illustrated below)

B & R Relays Ltd, Temple Fields, Harlow, Essex

B & R Relays are now in production with two dry reed relays. One of the main advantages of dry-reed construction is the very high life expectancy (20×10^6 operations at maximum contact rating).—The contact resistance is also interesting, being only 0·030Ω. The new relays are of the plug-in type. Type R01 is mounted on an 8-pin base, and will hold up to three reeds. Type R02, which apart from the base is the same size, has a 14-pin base, and has been designed to hold 4, 5 or 6 reeds. Both relays are d.c. operated, and measure 1⅛in in diameter, being about 3¼in high. The nominal operating power for one reed is 0·1W to 0·9W for six reeds.



EE 33 777 *for further details*

Meetings this Month

THE BRITISH INSTITUTION OF RADIO ENGINEERS

Date: 3 May. Time: 5.30 p.m.
Held at: The London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1.
Symposium: Computer Control of Air Traffic.
Date: 17 May. Time: 5.30 p.m.
Held at: The London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1.
Lecture: Video Tape Recording.

Southern Section

Date: 16 May. Time: 7 p.m.
Held at: Farnborough Technical College.
Lecture: Annual General Meeting of the Section followed by Electronic Techniques in the Measurement of Acoustic Noise.
By: K. R. McLachlan.

THE INSTITUTE OF NAVIGATION

Date: 12 May. Time: 5.15 p.m.
Held at: The Royal Geographical Society, Kensington Gore, London, S.W.7.
Lecture: Airborne Weather Radar.
By: R. C. Alabaster and P. L. Stride.

THE INSTITUTION OF ELECTRICAL ENGINEERS

All meetings will be held at Savoy Place, London, W.C.2, unless otherwise stated.

Electronics and Communications Section

Date: 1 May. Time: 5.30 p.m.
Lecture: Progress Report on the Development of a Photo-Electric Beam Index Colour Television Tube and System.
By: R. Graham, J. W. H. Justice and J. K. Oxenham.
Date: 8 May. Time: 5.30 p.m.
Lecture: The Corona-Discharge and its Application to Voltage Stabilization.
By: E. Cohen and R. O. Jenkins.
Lecture: Impedance Frequency Characteristics of Glow-Discharge Reference Tubes.
By: F. A. Benson and P. M. Chalmers.
Lecture: Comparison of Argon, Krypton and Xenon as Admixtures in Neon Glow-Discharge Reference Tubes.
By: F. A. Benson and G. P. Burdett.
Date: 15 May. Time: 5.30 p.m.
Lecture: Circuits for the Banana Tube Colour Television Display System.
By: K. G. Freeman.
Lecture: Mechanical and Manufacturing Aspects of the Banana Tube Colour Television Display System.
By: H. Howden.
Lecture: Appraisal of the Banana Tube Colour Television Display System.
By: K. G. Freeman and B. R. Overton.
Lecture: The Banana Tube Display System—A New Approach to the Display of Colour Television Pictures.
By: P. Schagen.
Lecture: Colorimetry of the Banana Tube Colour Television Display System.
By: R. N. Jackson.
Lecture: The Banana Tube.
By: B. A. Eastwell.
Date: 17 May. Time: 5.30 p.m.
Lecture: Air Traffic Control.
By: E. Eastwood and B. J. O'Kane.

Measurement and Electronics Section

Date: 2 May. Time: 5.30 p.m.
Lecture: Structural Properties and Applications of Evaporated Metal Films.
By: D. W. Pashley.
Lecture: Deposition of Evaporated Non-Magnetic Films.
By: J. R. Balmer.

Medical Electronics Discussion Group

Date: 5 May. Time: 5.30 p.m.
Lecture: Artificial Muscles.
By: A. G. Kinnear Wilson.

Supply Section

Date: 10 May. Time: 5.30 p.m.
Lecture: Electricity Supply in India and its Future.
By: M. Datta.

Education Discussion Circle

Date: 12 May. Time: 6 p.m.
Lecture: The Place of Transistors in National Certificate Courses.
By: B. F. Gray and W. B. K. Ellis.

Utilization Section

Date: 25 May. Time: 5.30 p.m.
Lecture: Electric Traction.
By: J. A. Broughall.

THE INSTITUTION OF ELECTRONICS

Date: 18 May. Time: 7 p.m.
Held at: The Lecture Theatre, The Byng Kenrick Suite, New College of Technology, Gosta Green, Birmingham, 4.
Lecture: Tunnel Diode Circuit Applications.
By: I. Aleksander.
Date: 19 May. Time: 7 p.m.
Held at: The Large Lecture Theatre, The London School of Hygiene and Tropical Medicine, Keppel St., Gower St., London, W.C.1.
Lecture: Aerial Techniques.
By: C. F. Whitbread.

THE SOCIETY OF INSTRUMENT TECHNOLOGY

Date: 11 May. Time: 7 p.m.
Held at: Manson House, 26 Portland Place, London, W.1.
Lecture: Control Mechanisms in the Human Nervous System.
By: Dr. W. Grey Walter.

PUBLICATIONS RECEIVED

KYBERNETIK is the title of a new German journal published by Springer-Verlag, Berlin. A prospectus giving details of this journal and subscription rates may be obtained from Springer-Verlag, Heidelberger Platz 3, Wilmersdorf, Berlin, Germany.

BY PRECISION TO PERFECTION is a brochure illustrating the facilities and range of activities of English Electric Valve Company. The brochure presents a general graphic description of the operations and applications which are peculiar to their industry—specialized valves. Inquiries should be addressed to Chief of Publicity, English Electric Valve Co. Ltd, Waterhouse Lane, Chelmsford, Essex.

A MAGNETIC TAPE RECORDING SYSTEM FOR NUCLEAR PHYSICS RESEARCH by I. N. Hooton of the Electronics Division of the U.K.A.E.A., Harwell, is the title of a report now available from Her Majesty's Stationery Office. Price 7s.

BRITISH STANDARD for Steel Sheets for Magnetic Circuits of Power Electrical Apparatus, Part 2: Orientated Steel, covers orientated magnetic steel strip and sheets intended primarily for machines and transformers operating at power frequencies, and applies to material which will be supplied in one nominal thickness only and in four grades. Tests are laid down for total losses and a.c. excitation, effect of ageing, stacking factor and insulation values. Test procedure and formulae and typical values are included in the five appendices. Copies of the Standard may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1. Price 5s.

MICHAEL FARADAY by A. Jeffreys is a bibliography of Faraday's lectures and published writings aimed at recording in a single sequence and in chronological order: all books and separate publications and all manuscript lecture notes in the Faraday Collection at the Royal Institution. The book is published by Chapman and Hall Ltd, price 42s.

SOME INDUSTRIAL USES OF PLATINUM METALS is a publication produced with the object of acquainting design engineers and technologists with the many and varied uses of the platinum metals. Inquiries should be addressed to the Baker Platinum Division of Engelhard Industries Ltd., 52 High Holborn, London, W.C.1.

OPPORTUNITIES FOR RESEARCH at the National Physical Laboratory is the title of a descriptive booklet recently published, which gives some of the facts about appointments in this Establishment. Further details and information may be obtained from the Director, National Physical Laboratory, Teddington, Middlesex.

RUSSIAN PATENTS is an English translation of the U.S.S.R. official bulletin of patents and inventions. A booklet giving information on the Russian patent system in order to give intending subscribers to this publication a chance to evaluate its use is available from Derwent Information Service, Dept. JP., Rochdale House, Theobalds Road, London, W.C.1. The annual subscription is £40 or $120.

PROCESS CONTROL—B.S. 1523: Section Two: 1960. This revised edition of Section Two of B.S. 1523, gives up-to-date definitions of the terms used in process industries for single closed-loop automatic control systems and is illustrated by diagrams. As much information as possible on the drafting of similar American and Continental glossaries has been obtained to avoid contradiction between such drafts and this British Standard. Copies of this standard may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1, price 6s.

MINING & CHEMICAL PRODUCTS LIMITED have recently published four booklets entitled as follows:—1, Semiconductors; 2, Thermoelectric Materials; 3, Bismuth Telluride Semiconductors and 5, Galvanomagnetic Effects and Materials. Copies are available on application to the above Company at 86 Strand, London, W.C.2.

TRAVELLING WAVE TUBES, Their Characteristics and Operation is the title of a booklet published for the purpose of providing an introduction to the travelling wave tube, giving a brief outline of its construction, characteristics, operation and typical applications, together with recommendations for obtaining optimum performance and life. This booklet is published by The English Electric Valve Co. Ltd, Chelmsford, Essex.

AN AUTOMATIC 1 000 CHANNEL READ-OUT SYSTEM by R. L. Elliott is the title of a Report describing an equipment which has been designed using relays and uniselectors to transfer digital information, originally stored on a ferrite matrix, from transistor trigger circuits on to perforated paper tape. Inquiries should be addressed to the Scientific Administration Office, Atomic Energy Research Establishment, Harwell, Didcot, Berks. Copies are available from H.M. Stationery Office, price 4s. 6d.

MARCONI INSTRUMENTS have recently published a new catalogue describing the Company's twenty-five years of uninterrupted design and manufacture of telecommunications measurement equipment. Inquiries should be addressed to Marconi Instruments Limited, St. Albans, Hertfordshire.

ONE HUNDRED AND TEN YEARS OF UNDERSEA TELECOMMUNICATIONS is a brochure which brings the history of submarine communication cables up to date and indicates the part played by Submarine Cables Limited and their predecessors. Copies of this leaflet are obtainable from Submarine Cables Limited, Publicity Dept., Mercury House, Theobald's Road, London, W.C.1.

THE A.R.R.L. ANTENNA BOOK contains information on antennas as may be useful to amateurs. The book has two principal divisions, chapters one to five deal with the principles of antennas and transmission lines, wave propagation and its relationship to antenna design, and the performance characteristics of directive antenna systems. Beginning with chapter six, there is a series of chapters in which complete data are given on specific designs for the various amateur bands. This book is published by The American Radio Relay League Inc., West Hartford, Connecticut, U.S.A., price $2.00.

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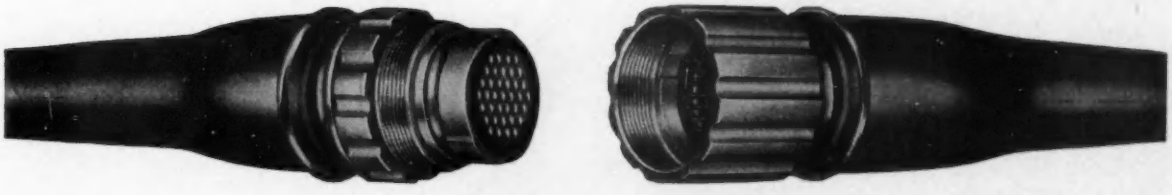
Robust, reliable and lightweight BICC Polypole Couplers and Multicore Cables are used exclusively by PYE as part of the standard equipment for their transportable long range television links.

BICC design and manufacture Polypole Coupler Systems to meet special requirements. These systems cover a wide variety of types and sizes of cable, terminated with moulded-on couplers.



Further information is contained in Publication No. TD TPC 5—available on request.

BRITISH INSULATED CALLENDER'S CABLES LIMITED 21 BLOOMSBURY STREET LONDON WC1

The Highest Sensitivity
and the lowest noise.....

Advanced electronic research by Hitachi technicians has now resulted in the development of a superb frame grid type twin triode (6R-HH8) with excellent high gain and low noise characteristics. As a component of the tuner, the 6R-HH8 ensures an excellent picture with a remarkable degree of definition.

fig. 1 Gain characteristics

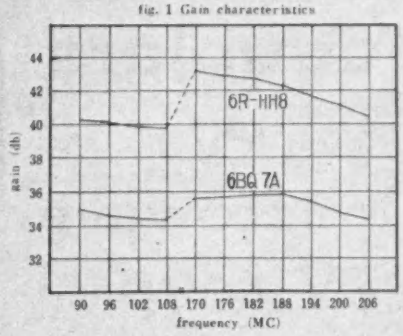
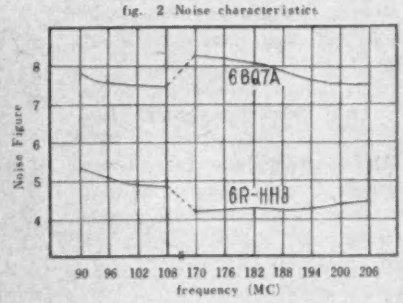
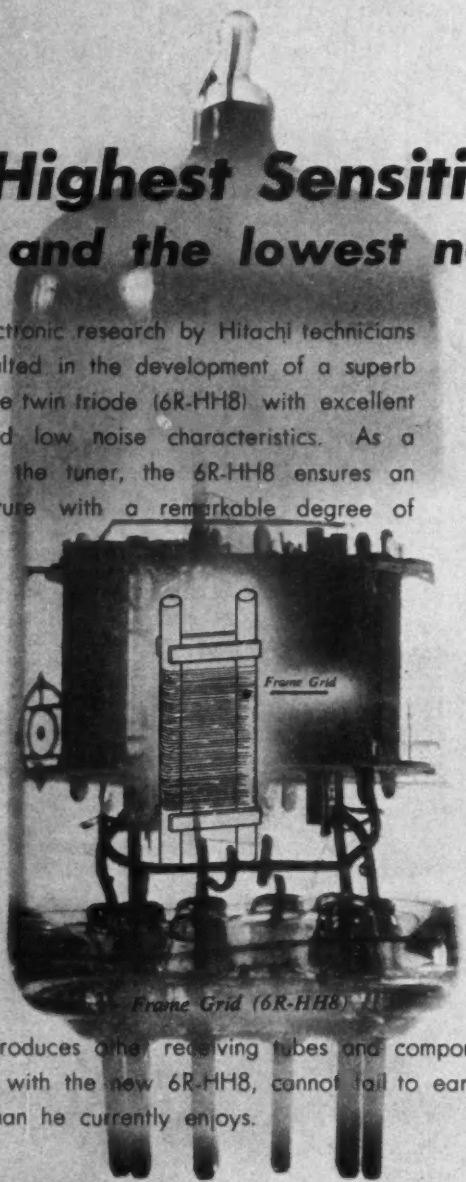


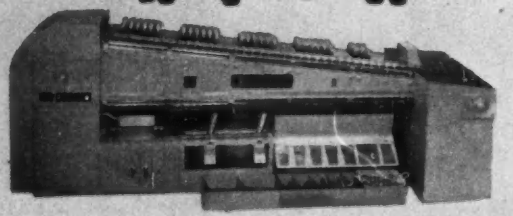
fig. 2 Noise characteristics





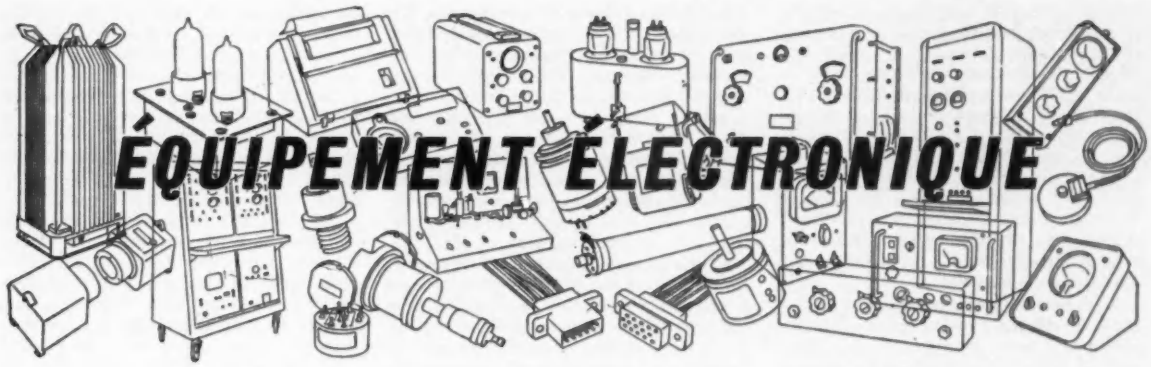
Frame Grid (6R-HH8)

Hitachi also produces other receiving tubes and components for television which, when used together with the new 6R-HH8, cannot fail to earn any maker a market reputation even better than he currently enjoys.



Automatic tube testing equipment

Hitachi, Ltd.
Tokyo Japan
Cable Address : "HITACHY" TOKYO



ÉQUIPEMENT ÉLECTRONIQUE

Une description basée sur des renseignements fournis par les fabricants de nouveaux organes, accessoires et instruments d'essai

Traduction des pages 324 à 329

PONT DE COMPARATEUR

Mec-Test Ltd, Henrietta House, Henrietta Place, London, W.1

(*Illustration à la page 324*)

Le Pont de mesures rapides Comparatron type 51 constitue un moyen rapide pour contrôler la précision de la valeur, en fonction de limites préétablies, de résistances, de condensateurs et de bobines d'inductance. Les deux cadrans de limites sont réglés à la tolérance voulue jusqu'à ±25% (par paliers de 0,2%) et les composants peuvent être contrôlés en une fraction de seconde.

Cet instrument est un pont d'impédances universel autonome secteur, fonctionnant à une fréquence de 1 kHz pour la comparaison rapide, dans des limites préétablies, de résistances, condensateurs et inductances des types et formats les plus courants dans le matériel radioélectrique et électronique. Quant il est utilisé manuellement, il contrôle les composants à la même vitesse que celle à laquelle ils sont appliqués aux contacts. L'affichage se fait par voyants de couleur indiquant "REJETER—TROP HAUTE" ou "REJETER-TROP BASSE" (l'indication acoustique est prévue, sur commande, pour les opérateurs aveugles). Dans ces conditions, le Pont de Mesures Rapides Comparatron est d'un fonctionnement aussi simple que celui de la jauge "ENTRE/N'ENTRE PAS."

La vérification des composants en cours de production automatique s'effectue en reliant un mécanisme de rejet aux contacts de relais appropriés. Le panneau à prises à l'avant de l'instrument permet le passage rapide de l'essai manuel au fonctionnement automatique.

Le Pont de Mesures rapides Comparatron est inaccessible aux parasites et aux effets de capacité manuelle. De plus, la stabilité des réglages est assurée par une balance de zéro à chaque limite. La tension de source du Pont est de 1,5V efficace équilibré à la masse (impédance 0.6Ω).

EE 33 751
pour plus amples renseignements

CELLULES PHOTOÉLECTRIQUES INFRAROUGES

Mullard Ltd, Mullard House, Torrington Place, London, W.C.1

(*Illustration à la page 324*)

La Maison Mullard a mis au point une nouvelle cellule photoconductive, la ORP13, qui aurait un pouvoir détecteur plus élevé que toute autre cellule photoélectrique pour applications infrarouges, tout en étant offerte à la vente dans le monde entier. Elle est destinée aux applications de la spectroscopie infrarouge et de la recherche dans les propriétés des matériaux.

Elle a une surface sensible d'environ 3 mm² d'antimoniure d'indium et elle est fixée à son propre flacon Dewar. Le refroidissement se fait par azote liquide à une température de 77°K (−196°C). Ce système de refroidissement permet d'obtenir de très bonnes valeurs de bruit et son efficacité est telle qu'il peut être utilisé pendant 45 minutes sans remplir à nouveau le flacon.

La gamme spectrale du ORP13 va du visible à environ 5,4 μ, la crête se produisant entre 4,5 et 5 μ. Sa sensibilité aux radiations monochromatiques est de 15 mV/uW de radiation incidente.

EE 33 752 *pour plus amples renseignements*

MICROVOLTMÈTRE ALTERNATIF

Marconi Instruments Ltd, St. Albans, Hertfordshire

(*Illustration à la page 324*)

Le Microvoltmètre alternatif type TF 1375 allie le gain élevé à l'absence de ronflement. Il dessert la plage de 5μV à 15V en douze gammes et il est entièrement transistorisé. Il est, en outre, complètement portatif et à alimentation autonome par batterie. Sa gamme de fréquences s'étend de 50Hz à 1 MHz avec rejet BF par sélecteur.

L'instrument se compose essentiellement d'un atténuateur d'entrée à compensation de fréquence avec plots décadaires, d'un amplificateur à compensation de fréquences à sept transistors ayant un gain de tension d'environ ×5000. La sortie de l'amplificateur est redressée dans un circuit en pont à deux alternances avant d'être appliquée au microvoltmètre. De plus, la sortie de l'avant-dernière étape est obtenue d'une sortie de panneau avant.

Le millivoltmètre de 102mm a un mouvement protecteur contre les surintensités avec tension nette de discrimination élevée et échelle de décibels.

Le TF1375 convient à de multiples applications; par exemple, comme préamplificateur d'oscilloscope, comme détecteur à pont de mesures sensible, ou bien encore pour les essais d'antenne et d'intensité de champ. A l'aide d'un cadre capteur approprié, on peut aisément mesurer le flux de fuite émanant de transformateurs secteurs et de moteurs électriques. L'impédance d'entrée et la sensibilité du microvoltmètre sont telles qu'il peut être utilisé comme microampèremètre pour déceler des courants n'atteignant pas plus de 10^{-16}A.

EE 33 753 *pour plus amples renseignements*

BLOC D'ALIMENTATION STABILISÉ

Allied Electronics Ltd, 28 Upper Richmond Road, Putney, London, S.W.15

(*Illustration à la page 324*)

Le "dernier né" de la série des blocs d'alimentation à stabilisation électronique ALTRON est le modèle EV 451-A. C'est un ensemble portatif dont les dimensions hors-tout sont 317 × 279 × 216mm et qui fournit des sorties de courant continu, fixe et variable, de 200V et de 0 à 300V respectivement, en plus d'une alimentation de chauffage de 6,3V 3A (c.a.).

L'alimentation variable peut être fixée à n'importe quelle tension dans la gamme de 0 à 300V par des commandes de

MESUCORA

(Mesure, Contrôle, Régulation et Automatisme) "ELECTRONIC ENGINEERING" occupera stand AB3-10 à la susdite Exposition qui se tiendra à Paris du 9 au 17 mai et sera heureuse d'y accueillir les visiteurs.

réglage précis et approximatif, et elle peut fournir jusqu'à 50mA à n'importe quelle tension entre 0 et 250V. La stabilité de la tension de sortie autour du point réglé est supérieure à ±0,015% pour des fluctuations du courant secteur de ±10% et pour toutes les valeurs de courant, du courant à vide au courant à pleine charge. La résistance intérieure de l'alimentation est inférieure à 0,25Ω et l'impédance est inférieure à 2Ω jusqu'à 50kHz. Un voltmètre et un ampèremètre sont reliés de manière permanente dans l'alimentation variable.

La tension d'ondulation maximum est de 1mV efficace dans n'importe quel cas. N'importe quel courant jusqu'à 8mA peut être tiré de l'alimentation fixe de 200V et les caractéristiques de l'alimentation diffèrent de celles de l'alimentation variables. Les deux alimentations en courant continu sont dirigées vers trois bornes, l'alimentation variable étant positive, l'alimentation fixe négative, par rapport à la borne commune: les deux alimentations sont isolées de la masse, de sorte que l'élément peut être utilisé pour produire une alimentation réduite de courant (0 à 8mA) de 0 à ±500V.

EE 33 754 *pour plus amples renseignements*

APPAREIL DE MESURE À PLUSIEURS SENSIBILITÉS

Distributeurs: Aveley Electric Ltd, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex

(Illustration à la page 325)

L'appareil de mesure Gossen, type UPHI, est un instrument robuste pour mesurer la tension alternative, le courant réel et réactif, le facteur de puissance, la fréquence, la résistance, l'angle de phase apparent et les forces de réaction.

La solidité et la souplesse d'emploi du UPHI, alliés à une échelle à miroir, en font un auxiliaire portatif des plus utiles pour l'utilisation dans la gamme de 40 Hz à 4 kHz.

Les lectures de l'échelle totale fournies par le UPHI vont de 12 à 600V, 60mA à 120A, 1 ohm à 100 kiloohms multigammes ±90° (cos ϕ sin ϕ) à 400Hz et 4kHz.

L'appareil est pourvu d'un mécanisme à cadre mobile, solide et de qualité supérieure, avec des coussinets à rubis montés sur resorts. Une batterie intérieure de 1,5V sert de source d'alimentation pour les mesures de résistance et un potentiomètre rotatif sert au réglage du zéro.

EE 33 755 *pour plus amples renseignements*

COMPTEURS DE LOTS

Pentechnique Ltd, Imperial Lane, Cheltenham, Gloucestershire

(Illustration à la page 325)

Des compteurs de lots compacts et à 2,3,4 ou 5 tubes Dékatrons, pouvant être fournis en divers modèles répondant à des applications particulières, constituent la toute dernière réalisation de la société Pentechnique Limited dans son assortiment d'éléments de comptage. Ces compteurs, qui peuvent compter des lots allant jusqu'à 99 999 pièces à une vitesse maxima de 5000 coups par seconde, sont alimentés par pick-ups magnétiques ou photoélectriques. La partie inférieure du compteur peut être munie de commandes et de circuits spécialement prévus pour le type de matériel d'alimentation devant être utilisé et le signal de sortie des lots peut être donné soit sous forme de fermeture de contact de relais soit sous forme de signal électrique.

Notre gravure montre un Compteur de lots à Dékatrons utilisé avec une trémie à cuvette vibratoire et un pick-up photoélectrique pour compter des quantités présélectionnées d'anneaux de caoutchouc. Deux simples réglages permettent l'adaptation à 15 dimensions différentes d'anneaux, d'un diamètre extérieur de 5,56mm à un diamètre extérieur de 23,8mm. Toutes les commandes y compris celles de la trémie à cuvette sont groupées sur le panneau inférieur du compteur de lots et des circuits spéciaux assurent le fonctionnement indéréglable. Le bouton de mise en marche réenclenche les Dékatrons à zéro afin de mettre en train le processus. Si, pour une raison quelconque, le réenclenchement est défectueux, la trémie à cuvette ne sera pas excitée. L'opérateur est donc dispensé de la nécessite de vérifier si le réenclenchement est correct. On presse le bouton d'arrêt lorsqu'on veut arrêter la trémie à cuvette au cours du comptage, la pression ultérieure du bouton de marche ne réenclenchant pas les Dékatrons mais permettant au comptage de se poursuivre à partir du point ou il a été arrêté.

Une variété de pick-ups magnétiques et photoélectriques peut être fournie pour déceler une gamme étendue de composants. Le montage des capteurs et l'adaptation des trémies à cuvette peuvent être assurés, le cas échéant, en fonction des conditions requises.

EE 33 756 *pour plus amples renseignements*

AGRAFES POUR SEMICONDUCTEURS

Rendar Instruments Ltd, Victoria Road, Burgess Hill, Sussex

(Illustration à la page 325)

Ces agrafes ont été conçues pour tenir fermement les transistors d'un diamètre de 4,76 à 6,35 mm. La base est un moulage de Polyprolylène et l'agrafage se fait par un ressort de cuivre en beryllium trempé. L'agrafe peut être fixée à un panneau par une vis de 2,2 mm de diamètre. Une cheville moulée empêche toute torsion.

EE 33 757 *pour plus amples renseignements*

VOLTMÈTRE À IMPÉDANCE ÉLEVÉE

Distributeurs: Scientific Furnishings Ltd, Poynton, Cheshire

(Illustration à la page 325)

Le voltmètre électrosensible Halex modèle 301E est un palpeur amplificateur de gain unitaire des plus sensibles ayant une précision de détection de courant continu de 0,001% et une sensibilité au courant de 10^{-16} A (60 électrons/sec). La résistance d'entrée effective est supérieure a $10^{17}\Omega$ et la capacité d'entrée est inférieure à 0,01 pF, de sorte que le temps de réponse est négligeable. Ses bornes de sortie d'impédance réduite et élevée sont de 0,2Ω et 500Ω respectivement.

Des boucliers de protection placés de manière fort appropriée à la borne d'entrée permettent l'utilisation d'instruments pour des travaux à énergie extrêmement basse sans qu'il soit nécessaire d'avoir recours à des capots de protection ou à des chambres cuirassées, et sans causer de longues constantes de temps pouvant déranger les lectures.

Le rendement du Voltmètre électrosensible résulte d'une méthode de réalisation connue sous le nom de "couplage relativiste" conçue aux Etats-Unis par Halex Incorporated. Huit étages d'amplification sont utilisés, comprenant un amplificateur électromètre flottant mais sans vibreurs ou découpeurs périodiques.

Le système se compose de trois amplificateurs de gain unitaires de précision, entièrement recouverts de trois écrans distincts, la masse de l'amplificateur le plus à l'intérieur servant d'écran aux amplificateurs suivants. Chacun des trois écrans est relié à l'un des trois boucliers de protection isolés en Teflon, placés de façon concentrique autour du conducteur d'entrée central, avec un bouclier de masse extérieur. Les trois boucliers de protection sont manœuvrés par les amplificateurs dans l'instrument a des tensions quasi identiques au signal d'entrée sur le conducteur central. L'effet de ce système est d'élever l'impédance d'entrée effective au dessus de l'isolement en Teflon et même au dessus de l'espace libre entourant l'instrument. La protection multiple empêche également le captage de parasites.

Le compteur d'entrée incorporé assure une précision d'affichage de 1%. Un commutateur offre le choix de onze gammes étalonnées avec des valeurs d'échelle totale allant de ±1 V à ±250 V c.c. ou 500 V crête à crête pour courant alternatif de basse fréquence. Des fréquences allant jusqu'à 1 kHz peuvent être admises à de faibles amplitudes à partir d'une source d'impédance réduite. La commutation de l'appareil de mesure n'affecte pas la résistance d'entrée, la sortie des bornes ou le gain des amplificateurs individuels. Après chauffage, le glissement est inférieur à 0,001% de la tension d'échelle totale.

EE 33 758 *pour plus amples renseignements*

AMPLIFICATEUR DE COURANT CONTINU TRANSISTORISÉ

Fenlow Electronics Ltd, Springfield Lane, Weybridge, Surrey

(Illustration à la page 326)

Cet amplificateur de courant continu à chopper stabilisé, entièrement transistorisé, est étudie pour l'emploi dans le contrôle de processus, dans le calcul

analogique et dans les applications générales d'amplification.

C'est un appareil à grand gain comprenant un canal de connexion à glissement secondaire qui fait usage d'un transistor écrêteur. La forme d'onde d'entraînement du chopper s'obtient d'un multivibreur incorporé au boîtier de l'amplificateur.

Le glissement est de l'ordre de 200μV, le bruit est inférieur à 100μV et la largeur de bande en chaîne ouverte est de 1kHz.

EE 33 759 *pour plus amples renseignements*

SONOMÈTRE

Distributeurs: B & K Laboratories, 4 Tilney Street, Park Lane, London, W.1

(Illustration à la page 326)

Le sonomètre de précision Brüel è Kjær, type 2203, est transistorisé, portatif et à fonctionnement par batterie. Il répond pleinement, en outre, aux normes internationales I.E.C. projetées pour les sonomètres de précision.

Doté d'un microphone capacitif de précision (B & K Type 4131), ce sonomètre donne une lecture d'échelle directe de 22 à 134dB, avec un degré de précision de ±1dB et la caractéristique de fréquence linéaire s'étend de 20 Hz à 15kHz. Une amplification totale de 110dB produit une déviation totale sur le sonomètre pour une tension d'entrée de 10μV. En appliquant une contre-réaction poussée, on assure la stabilité de fonctionnement de l'amplificateur. Un générateur de commande stabilisée incorporé permet une vérification immédiate de l'amplification. Les trois réseaux à atténuation prédéterminée IEC, pour sonomètres de précision, sont placés entre le premier et le second étage de l'amplificateur. Le circuit redresseur de l'appareil est du type quasi efficace, conformément aux normes de l'IEC.

L'appareil peut être rapidement converti en analyseur de fréquences en branchant des filtres extérieurs de 1/3 et 1/1 octaves, et lorsqu'un enregistrement permanent des mesures prises est nécessaire, un enregistreur de niveau peut être relié à sa sortie. En remplacant la cartouche du microphone par un adaptateur (adaptateur d'entrée JJ2612), il peut être transformé en amplificateur de vibrations et de tension. Enfin, en branchant un accéléromètre sur l'entrée, des mesures de vibrations peuvent être facilement effectuées.

Pour faciliter les mesures dans les lieux sombres ou mal éclairés, l'échelle du sonomètre peut être allumée. Durant le fonctionnement, une lampe pilote s'éclaire par intermittence pour indiquer la présence de la tension d'alimentation. Le sonomètre peut être fourni avec une solide valise portable en cuir.

EE 33 760 *pour plus amples renseignements*

VOLTMÈTRE ÉLECTRONIQUE

Taylor Electrical Instruments Ltd, Montrose Avenue, Slough, Buckinghamshire

(Illustration à la page 326)

Le voltmètre électronique modèle 172A est un instrument universel de format compact et d'une grande stabilité. Son impédance d'entrée est de 11MΩ sur courant continu et de 830 kΩ à 1,5MΩ dans les gammes de courant alternatif. Il peut être utilisé, conjointement avec une sonde piézoélectrique, à des fréquences de plus de 200 MHz.

Les gammes étalonnées sont: 0 à 1,5kV c.c. en sept gammes; 0 à 1,5kV c.a. efficace en sept gammes; 0 à 4,2kV c.a. crête à crête en sept gammes et 0 a 100 MΩ en sept gammes. Des lectures de courant continu allant jusqu'à 30 kV peuvent être effectuées à l'aide d'une sonde spéciale.

Le voltmètre comprend aussi une commande de réglage du zéro central et un commutateur d'inversion de polarité.

EE 33 761 *pour plus amples renseignements*

COMMUTATEUR DE PROXIMITÉ

The Donovan Electrical Co. Ltd, Granville Street, Birmingham 1

(Illustration à la page 326)

Ce commutateur de proximité est prévu pour remplacer les disjoncteurs de sécurité normaux dans les situations particulièrement ardues ou lorsqu'il n'est pas commode d'effectuer un contact physique avec un disjoncteur de sécurité à fonctionnement mécanique. La tête du détecteur est complètement scellée contre l'huile, etc. et elle ne contient pas de pièces mobiles. Etant donné que la tête ne renferme pas de noyau métallique ou d'aimant permanent, elle n'attire pas de poussières ferreuses ou de limaille.

Une surface métallique parfaitement plate et d'une superficie suffisante, soit 6 à 12 cm² placée à une distance d'environ 6 mm de la face plate de la tête, provoque le fonctionnement d'un relais dans l'élément de commande. La précision de répétition de l'opération dépend dans une certaine mesure de la méthode d'application, mais elle est normalement de l'ordre de 0,5 mm. A condition de présenter une surface suffisamment plate à la tête, tout type ou toute épaisseur de métal peut être détecté, mais la limaille ou la poussière de métal sont généralement sans effet car les particules sont trop petites pour pouvoir être détectées. La tête normale est de 38mm de diamètre et elle est couplée à l'élément de commande par un câble coaxial de 183cm de longueur. L'élément de commande se trouve dans un boîtier en tôle mesurant 178 × 152 × 114 mm.

Des variations étendues de la tension d'alimentation peuvent être effectuées à partir de la valeur nominale de 230 ou 400V. La consommation électrique normale de l'élément de contrôle est de 6W.

On peut obtenir des têtes spéciales pour la détection de toute rupture d'outil, ainsi que des éléments de contrôle spéciaux pour les systèmes de commutation statique. Le commutateur de proximité fonctionne selon le principe de couplage inductif plutôt que par capacité, de sorte qu'il n'est pas affecté par le captage parasite.

EE 33 762 *pour plus amples renseignements*

TUBES À RAYONS CATHODIQUES POUR INSTRUMENTS

Sylvania-Thorn Colour Television Laboratories Ltd, Great Cambridge Road, Enfield Middlesex

(Illustration à la page 327)

Un nouveau tube cathodique type SE5D, spécialement étudie pour l'oscillographie à grande largeur de bande et à action rapide, est actuellement produit par Sylvania-Thorn Colour Television Laboratories Ltd.

C'est un tube hélicoïdal de post-accélération de 127mm d'une grande précision et d'une sensibilité élevée, balayant 10cm dans la direction X et 5cm dans la direction Y. Il a une sensibilité Y de 3,5V/cm et une sensibilité X de 14V/cm, à une tension anodique finale de 10kV. Le rapport de post-accélération est de 12.

Quatre autres nouveaux tubes ont été réalisés par la Sté. Sylvania-Thorn en même temps que le SE5D.

Ainsi, le type SE5E est d'aspect identique au SE5D, mais il a une zone de balayage de 6cm × 10cm et une sensibilité Y de 5,5V/cm.

Le SE4A et le SE4B sont tout deux des tubes cathodiques de 102mm avec des zones de balayage de 5cm × 8cm, fonctionnant à des tensions finales de 8kV et de 4kV respectivement. La sensibilité X du SE4A est de 48V/cm et la sensibilité Y est de 15V/cm. Pour le SE4B, les sensibilités sont de 25V/cm. Les deux tubes ont un rapport de post-accélération de 4.

Le SE3A est un tube de 76mm avec zone d'exploration de 5cm × 6cm. Sa sensibilité X est de 27V/cm et sa sensibilité Y est de 7V/cm, la tension finale étant de 4kV.

EE 33 763 *pour plus amples renseignements*

MATÉRIEL À VIEILLISSEMENT DE TRANSISTORS

P.T.S. Electronics Ltd, 96 Horsenden Lane, Greenford, Middlesex

(Illustration à la page 327)

Cette installation est divisée en cinq fours séparés qui sont chauffés et thermoréglés à 45°C ±2°. Chaque four contient des rails de glissement portant des cartes à transistors, et chaque four contient quatre cartes, ce qui donne une contenance de 4000 transistors par four.

La circulation de l'air est effectuée par un ventilateur de 28m³/min. qui aspire l'air par une canalisation traversant chaque four.

Cinq blocs d'alimentation jumelés à la base de l'installation fournissent aux transistors une tension de 0 à 16V à 100A.

EE 33 764 *pour plus amples renseignements*

AMPLIFICATEUR BASSE-FRÉQUENCE

Goodmans Industries Ltd, Axiom Works, Lancelot Road, Wembley, Middlesex

L'amplificateur de puissance PASVA est un dispositif de 5W (régime continu) desservant la gamme de fréquences allant de 5Hz à 20kHz (±1dB) et il a

été principalement conçu pour actionner les générateurs de vibrations.

Le circuit se compose d'une double triode, faisant fonction d'amplificateur et de déphaseur multiple, actionnant une paire de lampes EL84 fonctionnant en push-pull dans des conditions ultra-linéaires. La contre-réaction totale est conduite du secondaire du transformateur de sortie à la cathode de la première lampe. La contre réaction dans la bande médiane est de 29dB, tombant à 26dB à 20kHz et à 22dB à 5Hz.

La distorsion totale est inférieure à 0,5% entre 50Hz et 10kHz à 5W.

EE 33 765 *pour plus amples renseignements*

OSCILLOSCOPE À DOUBLE FAISCEAU

Solartron Laboratory Instruments Ltd, Cox Lane, Chessington, Surrey

(Illustration à la page 327)

L'oscilloscope à double faisceau CD 1016 est un modèle compact prévu pour le montage sur bâti. Il comprend deux amplificateurs Y identiques ayant une largeur de bande allant du courant continu à 5 MHz, et un temps de montée d'environ 70 mμsec. Neuf gammes de sensibilité étalonnées vont de 100mV/cm à 50V/cm avec une précision de ±5%. En outre, une commande de réglage précis assure un contrôle continu jusqu'à environ 100V/cm. Le préamplificateur de courant alternatif intégral, précédant Y2, fournit six gammes de sensibilité supplémentaires avec une sensibilité maximum de 1mV/cm.

L'impédance d'entrée est de 1MΩ et 30pF. Les entrées peuvent être rendues "flottantes" jusqu'à 500V par rapport aux châssis, pour l'affichage de signaux isolés de la masse.

La base de temps va de 1cm/μsec à 2cm/sec, en dix-huit gammes étalonnées, dans la séquence 1-2-5, avec une précision de mesure de ±5%. Une commande de réglage précis avec une position d'étalonnage assure une zone d'action continue allant jusqu'à 1cm/sec. La vitesse maximum de balayage, soit 5cm/μsec peut être obtenue par l'emploi de l'extension X. L'oscilloscope peut être déclenché intérieurement ou extérieurement. Des commandes de "niveau" et de "stabilité" permettent le déclenchement précis et sûr à un point choisi de la forme d'onde affichée.

Une base de temps du type "lacet de botte" est utilisée; elle donne une linéarité supérieure à 1%. La forme d'onde de la base de temps (10V crête à crête) peut être obtenue d'une prise sur le panneau frontal.

L'amplificateur X (largeur de bande: du courant continu à 750kHz) a une sensibilité à variation continue de 0,15V/cm à 1,5V/cm. On peut accéder directement à cet amplificateur pour les signaux extérieurs.

Une impulsion "d'éclaircissement" de 30V, provenant d'un circuit bistable à part, couplée par courant direct au tube cathodique, donne des images parfaitement claires à toutes les vitesses de balayage. On peut également effectuer la modulation de l'intensité extérieure.

Une onde carrée de 0,5V crête a crête, à la fréquence secteur, permet au besoin d'étalonner la base de temps et la sensibilité Y.

La très-haute tension stabilisée permet de maintenir la précision d'étalonnage, quels que soient les niveaux d'intensité. Un tube cathodique à double canon de 89mm de diamètre, type 3AZP31, est utilisé dans l'oscilloscope CD1016.

EE 33 766 *pour plus amples renseignements*

GÉNÉRATEUR DE NEUTRONS

20th Century Electronics Ltd, Centronics Works, King Henry's Drive, New Addington, Croydon, Surrey

(Illustration à la page 327)

Cet instrument a été étudié pour assurer une source de neutrons d'intensité et d'énergie variables à l'intention des laboratoires.

Ses caractéristiques de base sont une sortie élevée de neutrons, une grande flexibilité expérimentale et le fonctionnement continu ou par impulsions.

Il utilise une réaction D.T. pour produire des neutrons de 14MeV. Les ions de deutérium sont accélérés vers une cible de tritium et la sortie de neutrons en fonctionnement continu est de l'ordre de 10^{10} neutrons par seconde. Les neutrons rapides peuvent être freinés pour produire des neutrons thermiques. Le générateur est à pompage continu et il a une tension d'accélération de 150kV.

En plus de son utilisation comme générateur de neutrons, il peut être adapté rapidement à la production des faisceaux d'ions accélérés de deutrons ou de protons pour d'autres applications de physique nucléaire.

EE 33 767 *pour plus amples renseignements*

POTENTIOMÈTRE DE PRÉCISION

Miles Electronics Ltd, Shoreham Airport, Sussex

(Illustration à la page 328)

Ce potentiomètre de précision a un diamètre extérieur de 19,8 mm et une profondeur de 25,4 mm. Quoique de dimensions réduites, il est, cependant de construction robuste et peut fonctionner pendant une longue période de temps sans que sa précision en soit affectée.

On peut fixer jusqu'à 33 prises de courant en plus des connexions d'extrémité normales. Les connexions de prises sont à un seul tour de fil et il n'y a donc pas de court-circuit des tours adjacents sur l'élément de résistance.

Les potentiomètres ont un couple de démarrage réduit, soit 5g.cm pour des valeurs de résistance supérieures à 10kΩ et 7g.cm pour des valeurs inférieures à 10 kΩ.

Jusqu'à 10 éléments jumelés peuvent être fournis et chaque groupe d'éléments n'ajoute que 19mm à la longueur de l'ensemble.

EE 33 768 *pour plus amples renseignements*

TUBE PHOTOMULTIPLICATEUR

Mullard Ltd, Mullard House, Torrington Place, London, W.C.1

(Illustration à la page 328)

Au début de l'année dernière, la société Mullard a présenté le tube photomultiplicateur 56AVP dont la réponse de crête est de 4200 Å et qui a été spécifiquement prévu pour l'emploi avec des scintillomètres exigeant une définition horaire très élevée.

La société Mullard vient d'annoncer un perfectionnement de ce tube qui est maintenant muni d'une fenêtre d'extrémité à quartz pour l'emploi avec les scintillomètres à gaz. Le nouveau type de tube, qui porte la référence 56UVP, ressemble beaucoup au 56AVP, mais sa réponse spectrale a été étendue bien à l'intérieur de la zone ultra-violette et sa réponse utile va jusqu'à 2300Å, avec une crête de 4000 Å (0,4 micromètres).

Pour les travaux à définition très élevée, des différences de temps de parcours électronique très réduites sont essentielles et ces différences ont été maintenues à 2,0mμsec à la hauteur d'une demi-impulsion, avec un temps de montée de la même durée.

Cette importante réduction des différences de temps de parcours électronique est due au dispositif électronique optique d'entrée de construction spéciale dont la photo-cathode est courbe pour que les longueurs de trajet vers le premier étage multiplicateur soient approximativement égales pour les électrons quittant n'importe quelle partie de sa zone utile. En fait, la différence de temps de parcours entre les électrons arrivant à la première dynode de la périphérie de la cathode photoélectrique et ceux provenant du centre n'est que de 0,3mμsec.

L'uniformité des temps de parcours à travers les 14 étages multiplicateurs est assurée par la forme appropriée des dynodes et par les dynodes supplémentaires de concentration situées entre chaque étage multiplicateur, qui rétrécissent graduellement le faisceau électronique d'étage en étage, malgre l'accroissement rapide du nombre d'électrons.

EE 33 769 *pour plus amples renseignements*

TUBE DE PRISE DE VUES VIDICON

English Electric Valve Co., Chelmsford, Essex

(Illustration à la page 328)

Le tube de prise de vues de télévision Vidicon 7038 a été réalisé par la English Electric Valve Co. Ltd. pour répondre à la diversité croissante d'applications Vidicon. Le tube est de conception suffisamment souple pour pouvoir être utilisé pour le balayage de films, pour les émissions de studio et pour les applications industrielles où plusieurs tubes spéciaux étaient utilisés jusqu'ici. Ses dimensions réduites et sa simplicité facilitent la réalisation et le fonctionnement de caméras et appareils connexes extrêmement compacts par rapport à ceux qui sont nécessaires pour des types de tubes de prise de vues plus

compliqués. Cette caractéristique est d'une valeur particulière pour la caméra en couleurs à trois tubes et pour les caméras industrielles nécessitant des dimensions hors-tout réduites.

Le tube 7038 a un pouvoir séparateur d'environ 600 lignes au centre du fond. Un élément photoconductif uniforme, sensible à la lumière, est utilisé. Il est caractérisé par une réponse virtuellement panchromatique donnant une reproduction fidèle des couleurs de la peau et fournissant une image semblable à celle d'autres tubes de prise de vues. Le tube 7038 a une sensibilité permettant la prise de vue en direct de scènes avec 1000 à 2000 Lux de lumière incidente en utilisant une ouverture de lentille de f/2.8 à f/40. Pour les images d'émission, une lumière de fond de 60 à 150 Lux dans les plages lumineuses est recommandée pour les prises de vue en direct, et de 1000 Lux pour l'analyse de films. Dans ces conditions de fonctionnement, les marbrures de l'image sont insignifiantes et son uniformité est parfaite. Pour les applications industrielles, ce tube à sensibilité élevée peut être utilisé avec une lumière minimum du fond de 20 Lux, n'occasionnant qu'une légère détérioration des autres paramètres.

EE 33 770 *pour plus amples renseignements*

BLOCS D'ALIMENTATION STABILISÉS

Fraser Speller Transformers Ltd, Sydenham Road, Sydenham, London, S.E.26

(Illustration à la page 328)

Ces blocs se prêtent à l'utilisation sur établi et à l'incorporation dans d'autres matériels. Le circuit est du type sans self et des condensateurs électrolytiques sont employés, ce qui donne un ensemble compact et relativement léger. Les blocs standards ont des tensions de sortie de ±150, 200, 250 et 300V, de 0 à 100mA. Les tensions non courantes peuvent être prévues sur commande. Deux puissances de sortie de 6,3V 3A c.a. sont également prévues. La stabilité de la tension de sortie est de l'ordre de 0,06% et l'ondulation efficace est inférieure à 2mV. La résistance de source efficace est inférieure à 0,1Ω et l'impédance de sortie est inférieure à 2Ω à toutes les fréquences.

EE 33 771 *pour plus amples renseignements*

MODULATEUR-INTERRUPTEUR TRANSISTORISÉ

Telephone Manufacturing Co. Ltd, Martell Road, West Dulwich, London, S.E.21

(Illustration à la page 329)

L'interrupteur au silicium Modèle SM10 est un petit dispositif transistorisé d'une grande stabilité prévu pour l'interruption de courant continu à un bas niveau. Il est du type à couplage direct et offre aux réalisateurs une forme simple d'interrupteur du type verouilleur. Il comporte un circuit incorporé de "façonnage" d'ondes et fonctionne à partir de n'importe quelle alimentation en ondes carrées ou sinusoïdales de 6 volts, de 40 Hz à 1 kHz. Il peut commuter une gamme de tensions de découpage de 1μV à 250mV.

Des composants judicieusement choisis et équilibrés sont utilisés pour assurer un glissement réduit et un rendement pratiquement indéfini. Vu que tous les composants sont sous moulage dans un récipient en aluminium, l'appareil est virtuellement à l'abri des vibrations et des effets de chocs. Contrairement aux obturateurs-rupteurs mécaniques il n'a aucune pièce mobile susceptible d'usure et ne nécessite aucun réglage. Il est, de plus, d'une grande stabilité dans une gamme étendue de températures.

EE 33 772 *pour plus amples renseignements*

GYROSCOPE INTÉGRATEUR MINIATURE

Ketay Ltd, Eddes House, Eastern Avenue West, Romford, Essex

(Illustration à la page 329)

Le nouveau gyroscope intégrateur miniature, type RI-203, qui vient d'être présenté par la Division Norden de la United Aircraft Corporation est maintenant offert sur le marché britannique par la société Ketay Ltd.

Les applications de ce gyroscope de précision comprennent la navigation inerte et le guidage d'engins et d'avions, la stabilisation des dispositifs de navires ainsi que de nombreuses autres applications exigeant des mesures angulaires dynamiques précises.

Les caractéristiques du nouveau gyroscope comprennent un taux de dérive réduit, la dérive aléatoire étant inférieure à 0,020/h, une stabilité d'une parfaite régularité, soit 0,100/h sans réglage, et une durée remarquablement longue allant jusqu'à 3000 heures. La dérive réduite a été réalisée grâce à un moteur rotatif ne tournant qu'à 12000 t/m, c'est à dire à une vitesse qui contribue dans une très grande mesure à la longue durée de l'instrument.

Ne mesurant que 79mm de long sur 50,8mm de diamètre, ce gyroscope de guidage pèse 454g, y compris le réchauffeur et les écrans.

EE 33 773 *pour plus amples renseignements*

GÉNÉRATEUR DE SIGNAUX POUR HYPER-FRÉQUENCES

R.E.E. Telecommunications Ltd, 15a Market Square, Crewkerne, Somerset

(Illustration à la page 329)

Ce générateur de signaux portatif, entièrement transistorisé, a une bonne stabilité de fréquence et une fuite réduite, ce qui le rend particulièrement indiqué pour les sensibilités élevées et l'espacement étroit des canaux des récepteurs hyper-fréquences modernes.

La gamme de fréquences s'étend de 115 à 135MHz et la tension de sortie va de 0,1μV à 10mV dans 75 ohms. La fuite haute-fréquence est inférieure à 0,2μV et le glissement de fréquence est inférieur à 5 kHz pendant une période de 10 minutes. La précision d'étalonnage est de 0,2%.

Le générateur est actionné par cellules de mercure intérieures.

EE 33 774 *pour plus amples renseignements*

BLOC ROTACTEUR MOTORISÉ DE TÉLÉVISION

The Plessey Co. Ltd, Vicarage Lane, Ilford, Essex

(Illustration à la page 329)

Nous nous excusons vivement auprès de nos lecteurs d'avoir publié par inadvertance une gravure se s'appliquant pas à la description du susdit appareil donné à la page 254 de notre numéro d'avril. Cette gravure montrait, en effet, un transformateur m.f. miniature fabriqué par The Wireless Telephone Co. Ltd, qui est une filiale de The Plessey Co. Ltd. La gravure appropriée figure ci-dessus.

EE 33 775 *pour plus amples renseignements*

ELECTROCARDIOGRAPHE PORTATIF

New Electronic Products Ltd, 360 Kennington Road, London, S.E.11

(Illustration à la page 329)

Cet électrocardiographe portatif miniature ne mesure que 228 × 102 × 102 mm et son poids complet, y compris l'étui de cuir, n'est que de 4 kg. C'est un appareil à transistors et circuits imprimés, alimenté par batteries intérieures rechargeables.

L'enregistrement s'effectue de manière visible et l'appareil comporte les caractéristiques courantes, telles qu'un choix complet de dérivations et la normalisation 1mV/cm avec commutateur de "division par deux."

La bande d'enregistrement a 15,24m de long sur 40mm de large, et des vitesses de 50mm/sec, 25mm/sec et 5mm/sec sont prévues. Le système d'enregistrement est du type à style graveur chaud et un microrupteur modifie la chaleur du style en liaison avec le choix de la vitesse.

L'impédance d'entrée est supérieure à 1 MΩ et la réponse de fréquence est inférieure à ±3dB du courant continu à 70Hz.

EE 33 776 *pour plus amples renseignements*

RELAIS À LAMES VIBRANTES SÈCHES

B & R Relays Ltd, Temple Fields, Harlow, Essex

(Illustration à la page 329)

La Société B & R Relays produit maintenant deux relais à lames vibrantes sèches. L'un des principaux avantages du montage à lames vibrantes sèches est sa très grande durée (20 × 10^6 opérations à un régime de contact maximum). La résistance de contact est également intéressante, n'étant que de 0,030 ohms. Les nouveaux relais sont du type à prises. Le type RO1 est monté sur une base à 8 broches et peut recevoir jusqu'à trois lames vibrantes. Le type RO2 qui, sauf pour la base, est de la même grandeur que le précédent, a une base à 14 broches et a été prévu pour contenir 4, 5 ou 6 lames vibrantes. Les deux relais fonctionnent sur courant continu et sont d'un diamètre de 35mm et d'une épaisseur de 108mm. La tension d'utilisation nominale d'une lame vibrante est de 0,1W et de 0,9W pour six lames.

EE 33 777 *pour plus amples renseignements*

Résumés des Principaux Articles

Un lecteur de documents marqués à la main par C. M. B. Reid

Résumé de l'article aux pages 274 à 278

Il s'agit ici d'un appareil simple pour la lecture de documents marqués à la main, tels que les factures. L'auteur donne un aperçu des raisons qui ont contribué à l'élaboration du projet et fait état des problèmes que pose la perception de marques faites à la main. La construction mécanique et optique du lecteur est brièvement expliquée, et elle suivie d'une description détaillée des diverses operations logiques par lesquelles s'effectue la "perception", le dépouillement, la centralisation et, enfin, la perforation sur bande magnétique des informations d'un document type. Des dispositifs d'alarme incorporés réduisent le risque d'erreurs dues à des plis ou à la crasse et leur utilité est indiquée dans un résumé de résultats d'opérations.

Réseau de contrôle et d'enregistrement automatiques par R. Mansey

Résumé de l'article aux pages 284 à 291

Cet article décrit un équipement britannique de contrôle et d'enregistrement automatiques prévu à l'origine pour un système d'engins téléguidés mais qui a également été trouvé approprié à n'importe quel avion ou appareil analogue dont les paramètres sont principalement électriques.

L'auteur examine les modes de réception des signaux d'entrée et fait une comparaison sélective avec un étalon. Il décrit la réalisation d'un potentiomètre à auto-équilibrage d'une conception inédite et montre comment on utilise l'entrée normalisée pour faire fonctionner un générateur bidirectionnel dit "à escalier" jusqu'à ce que la parité soit établie entre la sortie "en escalier" et l'entrée.

L'article conclut par un résumé succinct de l'application de l'appareillage au contrôle terrestre des systèmes de vol et de pilotage automatique d'avions avant leur décollage.

Un torsiomètre pour les études de fraisage par J. L. Gwyther

Résumé de l'article aux pages 292 à 295

L'auteur décrit un torsiomètre pour mesurer le couple de coupe d'une fraiseuse. Un transducteur du type à transformateur différentiel est utilisé et une signal de sortie permettant le fonctionnement d'un enregistreur à plume ou l'affichage d'un oscilloscope est fourni.

Un multivibrateur à transistors par B. Rakovich

Résumé de l'article aux pages 303 à 305

Un multivibrateur non asservi couplé à l'émetteur est décrit dans cet article. La durée d'états quasi stables est contrôlée en chargeant et en déchargeant un condensateur de minutage. Ce circuit fournit un moyen très pratique de produire des formes d'ondes rectangulaires symétriques et asymétriques avec une brève transition d'un état stable à l'autre. Un avantage supplémentaire de ce circuit est qu'il peut engendrer des impulsions rectangulaires de forme assez bonne et à des réquences très basses.

Un stabilisateur de tension perfectionné par A. K. Chatterjee, K. V. Ramanan et B. S. Rao

Résumé de l'article aux pages 308 à 311

Dans un stabilisateur de tension du type à amplification de contre-réaction, deux étages d'amplification de tension continue sont souvent utilisés dans un circuit en dérivation pour améliorer la stabilisation par rapport aux fluctuations de tension de sortie. Le présent article montre que la compensation d'entrée, introduite dans la grille d'arrêt du second tube amplificateur de tension continue, résulte en une stabilisation très élevée par rapport aux fluctuations de tension d'entrée. L'article conclut par des considérations sur la réalisation et l'amélioration des résultats du stabilisateur d'entrée compensé.

Amplificateurs à réaction pour calculateurs, laboratoires et usages industriels
Etude basée sur un rapport par J. Miedzinski et S.A. Patel, et rédigée par P. G. Kendall

Résumé de l'article aux pages 312 à 316

Les travaux expérimentaux sur les amplificateurs électroniques effectués relativement à l'étude et à la construction de l'analyseur de circuits E.R.A. ont montré les avantages et l'économie qu'assurent la possession d'un stock de quelques types d'amplificateurs courants.

La réalisation de tels amplificateurs est étudiée en détail. Un procédé systématique de conversion permettant de les adapter à des besoins particuliers est également discuté et éclairé par un exemple.

These pages *contain French and German translations of our "Electronic Equipment" pages and summaries of the main articles. It will be noted that each item in the "Electronic Equipment" Section concludes with a number. These numbers are for the use of readers who require further information about particular items and should be quoted on the Reader Information Service Card at the end of the journal.*

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On remarquera que chaque article dans la section ÉQUIPEMENT ELECTRONIQUE se termine par un numéro. Ces numéros sont à l'usage des lecteurs qui pourraient avoir besoin de renseignements complémentaires au sujet de certains de ces articles et ils doivent donc être rappelés sur la carte du "Service de Renseignements aux Lecteurs" à la fin de la revue.

Des pages d'annonces et de publicité en regard d'elles peuvent être réservées dans cette Section Etrangère aux annonceurs britanniques et d'outre-mer. Pour plus de détails, s'adresser au Chef de la Publicité.

Diese *Seiten bringen wir französische und deutsche Übersetzungen der Seiten „Elektronische Geräte" und der Zusammenfassungen der Hauptbeiträge.*

Am Fusse jeder Beschreibung in der Rubrik „Elektronische Geräte" steht eine Nummer. Leser, die an weiteren Auskünften über bestimmte Geräte interessiert sind, werden gebeten, diese Nummer auf der Leserdienstkarte am Ende des Heftes anzugeben.

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ELEKTRONISCHE GERÄTE

Beschreibung neuer Bauelemente, Zubehörteile und Prüfgeräte auf Grund der von Herstellern gemachten Angaben.

Übersetzung der Seiten 324 bis 329

Vergleichsbrücke

Mec-Test Ltd, Henrietta House, Henrietta Place, London, W.1

(*Abbildung Seite 324*)

Mit der "Comparatron"-Toleranzbrücke Type 51 kann schnell geprüft werden, ob der Wert von Widerständen, Kondensatoren und Induktionsspulen innerhalb vorgewählter Toleranzen liegt. Zwei Toleranzskalen können in Stufen von 0,2% für jede erforderliche Toleranz bis zu ±25% eingestellt und Bauelemente dann im Bruchteil einer Sekunde geprüft werden.

Das Gerät ist eine vollständige, netzbetriebene Universal-Scheinwiderstandsmessbrücke mit einer Betriebsfrequenz von 1 kHz zum schnellen Vergleichen der in Radio- und elektronischen Geräten am häufigsten anzutreffenden Widerstands-, Kondensator- und Induktionsspulentypen und -grössen innerhalb vorgewählter Toleranzen. Bei Handbedienung werden Bauelemente so schnell gemessen wie sie an die Klemmen angelegt werden können. Die Anzeige erfolgt durch farbige Lichtsignale für "Ausschuss hoch," "Gut" oder "Ausschuss niedrig." Für blinde Prüfer können Tonsignale vorgesehen werden. Unter diesen Umständen kann die Comparatron-Toleranzbrücke genau so einfach benutzt werden wie eine Anschlaglehre.

Für Bauelementprüfung in der automatischen Fertigung wurden die entsprechenden Relaiskontakte mit einer Ausstossvorrichtung verbunden. Eine Einsteckvorrichtung auf der Frontplatte des Gerätes ermöglicht schnelle Umstellung von Handprüfung auf automatischen Betrieb.

Die Comparatron-Toleranzbrücke ist gegen Störeinflüsse und Handkapazität unempfindlich, und konstante Einstellung wird durch Nullung für jede Toleranz gewährleistet. Die Brückenspannung ist 1,5 V_{eff} und symmetrisch geerdet (Quellenimpedanz 0,6Ω).

EE 33 751 *für weitere Einzelheiten*

Infrarote Fotozelle

Mullard Ltd, Mullard House, Torrington Place, London, W.C.1

(*Abbildung Seite 324*)

Mullard hat mit der Type ORP13 eine neue fotoleitende Zelle entwickelt, von der behauptet wird, dass sie eine höhere Nachweisfähigkeit hat als jede andere kommerziell lieferbare Fotozelle für Verwendung im infraroten Bereich in der Welt. Die Entwicklung erfolgte für Einsatz auf Gebieten, in denen infrarote Spektroskopie eine Rolle spielt, sowie für Forschungsarbeiten auf dem Gebiet der Materialeigenschaften.

Die Zelle hat eine empfindliche Indiumantimonfläche von 3 mm², ist mit ihrem eigenen Dewar Gefäss verbunden und wird mit flüssigem Stickstoff auf 77°K (−196°C) gekühlt. Durch dieses Kühlungssystem werden sehr gute Rauschzahlen erzielt. Es ist so wirksam, dass die Zelle bis zu 45 min ohne Auffüllung des Gefässes benutzt werden kann.

Der Spektralbereich der ORP13 liegt zwischen sichtbarem Licht und ungefähr 5,4 μ mit einer zwischen 4,5 und 5μ auftretenden Spitze. Ihre Empfindlichkeit für monochromatische Strahlung ist 15 mV/μW einfallende Strahlung.

EE 33 752 *für weitere Einzelheiten*

Mikrowechselspannungsmesser

Marconi Instruments Ltd, St. Albans, Hertfordshire

(*Abbildung Seite 324*)

Das Mikrovoltmeter für Wechselspannungen Type TF1375 vereinigt hohe Verstärkung mit Brummfreiheit. Der Messumfang von 5 μV...15 V ist in zwölf Stufen unterteilt; das Gerät ist volltransistorisiert, tragbar und arbeitet mit eingebauten Batterien. Der Frequenzbereich ist 50 Hz...1 MHz mit umschaltbarer NF-Sperre.

Das Gerät besteht im Grunde aus einem frequenzkompensierten Eingangsabschwächer mit Dekadenstufen und einem frequenzkompensierten 7-Transistor-Verstärker mit ungefähr 5000facher Verstärkung. Die Ausgangsspannung dieses Verstärkers wird in einer Doppelweg-Brückenschaltung gleichgerichtet, bevor sie zum Messwerk gespeist wird; ausserdem steht die Ausgangsspannung der vorletzten Stufe an Frontplattenklemmen zur Verfügung.

Das 102 mm Instrument mit Überlastungsschutz hat deutlich ablesbare Spannungs- und Dezibelskalen.

Der TF1375 kann für die verschiedensten Zwecke eingesetzt werden, z.B. als Oszillograf-Vorverstärker, als empfindlicher Messbrückenanzeiger oder für Feldstärke- und Antennentests. Mit einer geeigneten Suchschleife können von Netztransformatoren und Elektromotoren herrührende Streuflussmessungen leicht durchgeführt werden. Die Eingangsimpedanz und Empfindlichkeit ermöglichen Verwendung als Mikroammeter zum Nachweis von solch niedrigen Strömen wie 10^{-10} A.

EE 33 753 *für weitere Einzelheiten*

Stabilisiertes Netzgerät

Allied Electronics Ltd, 28 Upper Richmond Road, Putney, London, S.W.15

(*Abbildung Seite 324*)

Die neuste Ergänzung des "Altron"—Fertigungsprogramms elektronisch konstantgehaltener Netzgeräte ist Modell EV451-A. Die Abmessungen des tragbaren Gerätes sind 324 × 280 × 216 mm; feste und einstellbare Ausgangsgleichspannungen von 200 V und 0...300 V sowie eine Wechselspannung von 6,3 V 3 A für die Heizung werden abgegeben.

MESUCORA

(Messung, Steuerung, Regelung und Automation) Besucher der vom 9.-17. Mai in Paris stattfindenden Ausstellung sind auf dem Electronic Engineering Stand AB3-10 herzlich willkommen.

Die veränderliche Spannung kann mittels Grob- und Feinregelung auf einen beliebigen Wert im Bereich 0...300 V eingestellt werden und gibt für jede beliebige Spannung zwischen 0...250 V bis zu 50 mA ab. Für den eingestellten Ausgangsspannungswert ist die Stabilität für Netzschwankungen von ±10% und alle Stromwerte von Leerlauf bis zu Vollast besser als ±0,015%. Der Innenwiderstand des Gerätes ist unter 0,25Ω und die Impedanz bis zu 50 kHz unter 2Ω. Ein Spannungs- und ein Strommesser überwachen den einstellbaren Ausgang dauernd.

Die max. Restwelligkeit ist unter allen Betriebsbedingungen 1 mV_{eff}. Bis zu 8 mA können den Klemmen der 200 V-Festspannung entnommen werden; die anderen technischen Daten sind sonst wie für die einstellbare Spannung. Die beiden Gleichstromspannungen liegen an drei Ausgangsklemmen; die einstellbare Spannung ist positiv und die Festspannung negativ in Bezug auf die gemeinsame Klemme; beide Spannungen sind erdfrei, so dass das Gerät bei niedrigem Stromverbrauch (0...8 mA) eine Spannung von 0...±500 V abgeben kann.

EE 33 754 *für weitere Einzelheiten*

Mehrzweck-Messgerät

Vertrieb: Aveley Electric Ltd, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex

(Abbildung Seite 325)

Das Gossen Messgerät Type UPHI ist ein robustes Mehrzweck-Instrument zur Messung von Wechselstromspannung, Wirk- und Blindstrom, Leistungsfaktor, Frequenz, Widerstand, Scheinphasenwinkel und Blindleistung.

Vielseitigkeit und robuste Konstruktion sowie die Spiegelskala machen das UPHI zu einem sehr nützlichen tragbaren Messgerät für Messungen im Bereich von 40 Hz ... 4 kHz.

Das UPHI gibt Vollausschlaganzeigen von 12...600 V, 60 mA...120 A, 1Ω...100 kΩ in mehreren Bereichen, ±90° (cos Q sin Q) bei 400 Hz und 4 kHz.

Das Instrument hat ein kräftiges, hochwertiges Drehspulmesswerk mit federbelasteten Edelsteinlagern. Eine interne 1,5 V—Batterie ist die Spannungsquelle für die Widerstandsmessungen; für die Nullstellung wird ein Drehpotentiometer benutzt.

EE 33 755 *für weitere Einzelheiten*

Vorwahlzählgerät

Pentechnique Ltd, Imperial Lane, Cheltenham, Gloucestershire

(Abbildung Seite 325)

Kompakte Vorwahlzählgeräte mit 2, 3, 4 oder 5 Dekatronröhren sind die neusten Entwicklungen im Zählerprogramm der Pentechnique Ltd. Sie können mit vielen Abwandlungen für Spezialverwendungszwecke geliefert werden und können vorgewählte Vorgänge bis zu 99 999 mit einer Höchstfrequenz von 5 kHz von fotoelektrischen oder magnetischen Gebern zählen. Der untere Teil des Gerätes kann die Steuergeräte und Schaltungen aufnehmen, die besonders für die Zuführungsvorrichtung ausgelegt sind. Das Ausgangssignal für die vorgewählte Menge kann entweder Relaiskontakte schliessen oder eine elektrische Anzeige geben.

Die Abbildung zeigt einen 5-Dekatron-Vorwahlzähler, der mit einer Rüttelzuführungsschale und fotoelektrischem Geber benutzt wird, um vorgewählte Mengen von O-Gummiringen zu zählen. Durch zwei einfache Einstellungen können 15 verschiedene Grössen von 5,5 bis 24 mm Aussendurchmesser gezählt werden. Alle Steuerorgane, einschliesslich derjenigen für die Rüttelschale, sind auf der unteren Frontplatte des Zählers angeordnet, und Spezialschaltungen sichern gegen falsche Bedienung. Der "Start"-Knopf stellt die Dekatrons auf Null und leitet die Zählung ein. Die Rüttelschale wird nicht erregt, falls die Rückstellung aus irgend einem Grund fehlerhaft ist. Dadurch braucht der Arbeiter nicht zu prüfen, ob die Rückstellung richtig erfolgte. Sollte es erforderlich sein, die Rüttelschale während des Zählens auszuschalten, wird der "Halt"-Knopf gedrückt. Bei nachfolgender Betätigung des "Start"-Knopfes werden die Dekatrons nicht zurückgestellt, und die unterbrochene Zählung läuft weiter.

Die verschiedensten magnetischen und fotoelektrischen Geber sind für eine grosse Auswahl von Bauelementen lieferbar. Auf Wunsch können Befestigungsvorrichtungen für Geber und Änderungen der Rüttelschale ausgeführt werden.

EE 33 756 *für weitere Einzelheiten*

Halbleiter-Halterung

Rendar Instruments Ltd, Victoria Road, Burgess Hill, Sussex

(Abbildung Seite 325)

Diese Halterung wurde zur festen Verankerung von Transistoren mit Durchmessern von 4,75 ... 6,35 mm konstruiert. Die Grundplatte ist aus Polypropylen gepresst und mit einer gehärteten Beryllkupferfeder ausgerüstet. Befestigung auf einer Schaltungsplatte erfolgt mittels einer 8BA-Schraube (2,2 mm), und ein angepresster Stift verhindert jedes Verdrehen.

EE 33 757 *für weitere Einzelheiten*

Hochohmiges Voltmeter

Vertrieb: Scientific Furnishings Ltd, Poynton, Cheshire

(Abbildung Seite 325)

Das Halex "Electrosenser" Voltmeter Modell 301E ist ein empfindlicher Präzisions-Folgeverstärker mit dem Verstärkungsfaktor 1, einer Gleichspannungs-Folgegenauigkeit von 0,001% und einer Stromempfindlichkeit von 10^{-16}A (60 Elektronen/Sek). Der Eingangswirkwiderstand ist höher als $10^{17}\Omega$ und die Eingangskapazität geringer als 0,01 pF, so dass die Einstellzeit vernachlässigbar ist. Nieder- und hochohmige Ausgangsklemmen von weniger als 0,2Ω bzw. 500Ω sind vorgesehen.

Die bequem angeordneten Abschirmungen der Eingangsklemmen ermöglichen Messung äusserst geringer Energien ohne grosse und umständliche Abschirmhauben oder geschirmte Kabinen und ohne Störung der Ablesung durch lange Zeitkonstanten.

Die Leistung des "Electrosenser" Voltmeters ist auf eine von der Halex Incorporated in USA entwickelte Bautechnik zurückzuführen, die als "relativistic coupling" (relativistische Kopplung) bezeichnet wird. Acht Verstärkerstufen einschliesslich eines erdfreien Elektrometerverstärkers finden Verwendung, jedoch ohne Vibratoren oder Zerhacker.

Das System besteht aus drei Präzisionsverstärkern mit Verstärkungsfaktor 1, die vollständig von drei getrennten Abschirmungen umgeben sind; die Erde des innersten Verstärkers dient als Abschirmung für den folgenden Verstärker. Jede der drei Abschirmungen ist mit einer der drei durch Teflon isolierten Schutzabschirmungen verbunden, die zusammen mit einer Erdabschirmung konzentrisch um den Eingangsinnenleiter liegen. Die drei Schutzabschirmungen werden von den Verstärkern des Gerätes mit Spannungen getrieben, die dem Eingangssignal am Innenleiter fast gleich sind. Als Resultat dieser Anordnung wird der wirksame Eingangswiderstand über den der Teflonisolation angehoben und liegt sogar über dem der Aussenluft, die das Gerät umgibt. Durch die Mehrfachabschirmung wird auch die Aufnahme von Fremdenergie verhindert.

Das eingebaute Ausgangsmessgerät hat eine Anzeigegenauigkeit von 1%. Durch einen Schalter können wahlweise elf Bereiche mit Vollausschlagswerten von ±1 V bis zu ±250 V Gleichspannung oder 500 V Doppelspitzenwert niederfrequenter Wechselspannung eingestellt werden. Frequenzen können bei niedriger Amplitude und niedrigem Quellenwiderstand bis zu 1 kHz gehen. Die Bereichumschaltung beeinflusst weder den Eingangswiderstand noch den Ausgang an den Klemmen oder die Verstärkung der einzelnen Verstärker. Die Drift ist nach der Anwärmezeit geringer als 0,001% des Vollausschlages.

EE 33 758 *für weitere Einzelheiten*

Transistorisierter Gleichspannungsverstärker

Fenlow Electronics Ltd, Springfield Lane, Weybridge, Surrey

(Abbildung Seite 326)

Dieser volltransistorisierte, zerhackerstabilisierte Gleichspannungsverstärker

ist für Verwendung in der Verfahrensregelung, in Analogrechnern und für allgemeinen Verstärkereinsatz bestimmt.

Das Gerät hat hohe Verstärkung und einen eingebauten Hilfskanal für Driftkorrektur mit Zerhacker-Transistor. Die den Zerhacker treibende Wellenform wird von einem Multivibrator erzeugt, der im Verstärkergehäuse eingebaut ist.

Die Drift liegt bei 200 μV, die Rauschspannung ist unter 100 μV und die Bandbreite bei offener Schleife 1 kHz.

EE 33 759 *für weitere Einzelheiten*

Lautstärkemesser

Vertrieb: B & K Laboratories, 4 Tilney Street, Park Lane, London, W.1

(Abbildung Seite 326)

Der Brüel und Kjær Präzisionslautstärkemesser Type 2203 ist transistorisiert, tragbar und batteriegespeist. Er ist so ausgelegt, dass er den IEC-Normenvorschlägen für Präzisionslautstärkemesser voll entspricht.

Das mit einem Präzisionskondensatormikrofon B & K Type 4131 ausgerüstete Gerät hat direkte Skalenablesung von 22...134 dB mit ±1 dB Genauigkeit; der lineare Frequenzgangbereich liegt zwischen 20 Hz und 15 kHz. Die Gesamtverstärkung von 110 dB gibt Vollausschlag für eine Eingangsspannung von 10 μV. Durch starke Gegenkopplung wird der stabile Betrieb des Verstärkers gewährleistet. Ein eingebauter stabilisierter Eichgenerator ermöglicht eine einfache Prüfung der Verstärkung. Zwischen der ersten und zweiten Verstärkerstufe sind die drei IEC-Bewertungsfilter für Präzisionslautstärkemesser eingeschaltet. Der Messwerkgleichrichter gibt den für die IEC-Normen erforderlichen quasiquadratischen Mittelwert.

Durch Einschaltung externer Terz- und Oktavenfilter kann das Instrument schnell in einen Frequenzanalysator umgewandelt und ein Pegelschreiber am Ausgang angeschlossen werden, wenn eine Daueraufzeichnung der Messungen erforderlich ist. Durch Austausch der Mikrofonkapsel gegen einen Adapter (Eingangsadapter JI2612) kann das Gerät in einen Spannungs- und Schwingungsverstärker umgewandelt werden. Ein in den Eingang geschalteter Beschleunigungsmesser macht Schwingungsmessungen möglich.

Die Skala kann beleuchtet werden, um Messungen an dunklen und schlecht beleuchteten Plätzen zu erleichtern. In Betrieb zeigt ein regelmässig aufleuchtendes Signal an, dass die Stromversorgung arbeitet. Das Instrument kann in einer stabilen Ledertragtasche geliefert werden.

EE 33 760 *für weitere Einzelheiten*

Röhrenvoltmeter

Taylor Electrical Instruments Ltd, Montrose Avenue, Slough, Buckinghamshire

(Abbildung Seite 326)

Das Modell 172A ist ein Universalröhrenvoltmeter kompakter Abmessungen und guter Stabilität. Der Eingangswiderstand für die Gleichspannungsbereiche ist 11 MΩ und für die Wechselspannungsbereiche zwischen 830 kΩ und 1,5 MΩ. Mit Hilfe eines Quarzmesskopfes kann das Instrument für Frequenzen bis über 200 MHz benutzt werden.

Der geeichte Messumfang ist 0 ... 1,5 kV Gleichspannung in sieben Bereichen; 0 ... 1,5 kV effektive Wechselspannung in sieben Bereichen; 0 ... 4,2 kV Wechselspannung Spitze-zu-Spitze in sieben Bereichen und 0...100 MΩ in sieben Bereichen. Mit einem Spezialmesskopf können Gleichspannungen bis zu 30 kV abgelesen werden.

Einstellung eines Nullpunktes auf der Skalenmitte und ein Umpolungsschalter sind vorgesehen.

EE 33 761 *für weitere Einzelheiten*

Annäherungsschalter

The Donovan Electrical Co. Ltd, Granville Street, Birmingham 1

(Abbildung Seite 326)

Dieser Annäherungsschalter wurde entwickelt, um unter besonders schwierigen Bedingungen, oder wo direkte mechanische Kontaktbetätigung unerwünscht ist, mechanisch betätigte Endschalter zu ersetzen. Der Fühlkopf ist völlig gegen Öl, Schaum usw. abgedichtet und hat keine beweglichen Teile. Da der Kopf weder einen Eisenkern noch einen Dauermagneten enthält, werden eisenhaltige Staubteilchen oder Späne nicht angezogen.

Wenn eine genügend grosse, halbwegs ebene Metalloberfläche (zwischen 6 und 13 cm²) bis auf ungefähr 6 mm an die gerade Kopffläche herankommt, spricht das Relais des Steuergerätes an. Die reproduzierbare Genauigkeit des Vorgangs hängt zu einem gewissen Grad von der Verwendungsmethode ab, liegt jedoch üblicherweise bei, 0,5 mm. Solange die dem Kopf gegenüberstehende Fläche flach genug ist, wird jede Metallart oder -dicke erfasst; aber Späne und Metallstaub haben normalerweise keinen Einfluss, da sie zu klein sind. Der Standardkopf hat einen Duchmesser von 38,1 mm und ist über ein 1,80 m langes koaxiales Kabel mit dem Steuergerät verbunden. Das Steuergerät ist in einem Stahlblechgehäuse von 178 × 152,5 × 114,5 mm untergebracht.

Grosse Netzschwankungen sind für die Nennspannungen von 230 V oder 400 V zulässig. Das Steuergerät hat einen Leistungsbedarf von 6 W.

Spezialköpfe für die Anzeige von Werkzeugbruch und Spezialsteuergeräte für kontaktloses Schalten sind lieferbar. Der Annäherungsschalter arbeitet nach dem Prinzip der induktiven Kopplung und nicht kapazitiv, so dass er durch Störaufnahme nicht beeinflusst wird.

EE 33 762 *für weitere Einzelheiten*

Elektronenstrahlröhren für Oszillografen

Sylvania-Thorn Colour Television Laboratories Ltd, Great Cambridge Road, Enfield, Middlesex

(Abbildung Seite 327)

Eine besonders für Breitband- und Kurzzeitoszillografen entwickelte neue Elektronenstrahlröhre wird jetzt von der Sylvania-Thorn Colour Television Laboratories Ltd. hergestellt.

Die neue hochempfindliche 127 mm—Präzisions-Elektronenstrahlröhre Type SE5D hat spiralförmige Nachbeschleunigung mit 10 cm Auslenkung in X-Richtung und 5 cm in Y-Richtung. Die Y-Empfindlichkeit ist 3,5 V/cm, die X-Empfindlichkeit 14 V/cm bei einer Spannung von 10 kV an der letzten Anode. Das Nachbeschleunigungsverhältnis ist 12.

Mit der SE5D hat Sylvania-Thorn vier weitere neue Röhren herausgebracht.

Die SE5E ist in Gestaltung mit der SE5D identisch, hat aber eine Ablenkfläche von 6 × 10 cm und eine Y-Empfindlichkeit von 5,5 V/cm.

Die SE4A und SE4B sind 102 mm—Röhren mit einer Ablenkfläche von 5 × 8 cm mit 8 kV bzw. 4 kV Spannung an der letzten Anode. Die SE4A hat eine X-Empfindlichkeit von 48 V/cm und eine Y-Empfindlichkeit von 15 V/cm; die Ablenkfaktoren der SE4B sind 25 V/cm. Beide Röhren haben ein Nachbeschleunigungsverhältnis von 4.

Die SE3A ist eine 76 mm—Röhre mit einer Ablenkfläche von 5 × 6 cm. Die X-Empfindlichkeit ist 27 V/cm, die Y-Empfindlichkeit 7 V/cm und die Spannung an der letzten Anode 4 kV.

EE 33 763 *für weitere Einzelheiten*

Transistor-Alterung

P.T.S. Electronics Ltd, 96 Horsenden Lane, Greenford, Middlesex

(Abbildung Seite 327)

Die Anlage besteht aus fünf getrennten Öfen, deren Temperatur mittels Thermostaten auf 45°C ±2° eingeregelt ist. Jeder Ofen ist mit Laufschienen für vier Transistor-Ladeplatten ausgerüstet, so dass er eine Kapazität von 4000 Transistoren hat.

Die Luftumwälzung erfolgt durch einen Ventilator mit 28 m³/min Leistung, der über Kanäle Luft durch jeden Ofen zieht.

Im Stand der Anlage sind fünf Doppel-Netzgeräte untergebracht, die 0...16 V 100 A für den Strombedarf der Transistoren abgeben.

EE 33 764 *für weitere Einzelheiten*

NF-Leistungsverstärker

Goodmans Industries Ltd, Axiom Works, Lancelot Road, Wembley, Middlesex

Der Leistungsverstärker PASVA gibt im Dauerbetrieb über einen Frequenzbereich von 5 Hz...20 kHz (±1 dB) 5 W ab und ist in erster Linie als Treiber von Schwingungsgeneratoren gedacht.

Die Schaltung besteht aus einer als Verstärker und Phasenteiler wirkenden Doppeltriode, die ein Paar in ultralinearer Gegentaktschaltung arbeitende EL84—Röhren treibt.

EE 33 765 *für weitere Einzelheiten*

Zweistrahl-Oszillograf

Solartron Laboratory Instruments Ltd, Cox Lane, Chessington, Surrey

(Abbildung Seite 327)

Modell CW1016 ist ein kompakter Zweistrahl-Oszillograf, der für Gestelleinbau bestimmt ist.

Er hat zwei identische Y-Verstärker mit einer Bandreite von 0...5 MHz und einer Anstiegszeit von ungefähr 70 ns. Neun geeichte Bereiche geben ±5% Genauigkeit zwischen 100 mV/cm und 50 V/cm. Zusätzlich gibt eine Feinregelung eine ununterbrochene Überstreichung bis zu ungefähr 100 V/cm. Y 2 ist ein eingebauter Wechselstromvorverstärker vorgeschaltet, der sechs weitere Empfindlichkeitsbereiche mit einer Höchstempfindlichkeit von 1 mV/cm ergibt.

Die Eingangsimpedanz ist 1 MΩ und 30 pF Eingangsspannungen bis zu 500 V können "massefrei" zugeführt werden, um von Erde isolierte Signale darzustellen.

Die Zeitablenkung hat über den Bereich von 1 cm/μs...2 cm/s 18 geeichte Stufen in 1-2-5 Reihe mit ±5% Messgenauigkeit. Eine Feinregelung mit geeichten Positionen ermöglicht kontinuierliche Einstellung bis zu 1 cm/s. Eine Höchstablenkgeschwindigkeit von 5 cm/s kann durch Benutzung der X-Dehnung erzielt werden. Der Oszillograf kann intern oder extern getriggert werden. "Pegel"- und "Stabilität"-Regler ermöglichen genaues und zuverlässiges Triggern für vorgewählte Punkte der dargestellten Wellenform.

Die Schaltung der Zeitablenkung arbeitet mit mitlaufender Ladespannung und gibt eine Geradlinigkeit, die besser als 1% ist. Die Zeitablenkungswellenform (10 V Spitze-zu-Spitze) ist zu Buchsen auf der Frontplatte herausgeführt.

Der X-Verstärker hat eine Bandbreite von 0...750 kHz und eine kontinuierlich regelbare Empfindlichkeit von 0,15 V/cm...1,5 V/cm. Der Verstärker ist für externe Signale direkt zugänglich.

Ein 30 V—Aufhellimpuls wird in einer getrennten bistabilen Schaltung erzeugt, die mit der Elektronenstrahlröhre gleichspannungsgekoppelt ist und gibt bei allen Ablenkgeschwindigkeiten helle Sichtanzeige. Externe Helligkeitsmodulation kann auch benutzt werden.

Zur Eichung der Zeitablenkung und Y-Empfindlichkeit ist eine Rechteckwellenform mit 0,5 V Spitze-zu-Spitze bei Netzfrequenz vorgesehen.

Die Eichgenauigkeit wird durch stabilisierte Hochspannung unabhängig vom Helligkeitswert gewährleistet. Die benutzte Elektronenstrahlröhre Type 3AZP31 hat zwei Strahlerzeuger und einen Schirmdurchmesser von 89 mm.

EE 33 766 *für weitere Einzelheiten*

Neutronengenerator

20th Century Electronics Ltd, Centronics Works, King Henry's Drive, New Addington, Croydon, Surrey

(Abbildung Seite 327)

Dieses Gerät wurde als Neutronenquelle mit veränderlicher Intensität und Energie für Laborverwendung entwickelt. Als wesentliche Merkmale sind zu nennen: hohe Neutronenerzeugung, Versuchsanpassungsfähigkeit und Dauer- oder Impulsbetrieb.

Eine Deuterium-Tritium Reaktion wird zur Erzeugung der 14 MeV—Neutronen benutzt. Deuteriumionen werden auf das Tritiumziel beschleunigt; im Dauerbetrieb ist die Neutronenleistung 10^{10} Neutronen pro Sekunde. Schnelle Neutronen werden gebremst, um thermische Neutronen zu erzeugen. Das Gerät wird laufend gepumpt und hat eine Beschleunigungsspannung von 150 kV.

Ausser der Verwendung als Neutronenerzeuger kann das Gerät auch zusätzlich schnell auf Abgabe beschleunigter Ionenstrahlen von Deuteronen und Protonen eingerichtet werden.

EE 33 767 *für weitere Einzelheiten*

Präzisionspotentiometer

Miles Electronics Ltd, Shoreham Airport, Sussex

(Abbildung Seite 328)

Dieses Präzisionspotentiometer hat einen Aussendurchmesser von 55 mm und ist 25,4 mm hoch. Trotz der kleinen Abmessungen ist es robust gebaut und kann lange Zeit ohne Genauigkeitsverlust arbeiten.

Ausser den üblichen Endverbindungen können bis zu 33 Abgriffe vorgesehen werden. Abgriffe erfolgen an Einzelwindungen des Drahtes, so dass nebeneinander liegende Windungen des Widerstandselementes nicht kurzgeschlossen werden.

Für Widerstandswerte über 10kΩ haben die Potentiometer das kleine Antriebsmoment von 5 cmg; unter 10 kΩ beträgt es 7 cmg.

Bis zu 10 Potentiometer können auf einer Welle gestapelt werden, wobei jeder Gang die Länge des Satzes um nur 19,84 mm erhöht.

EE 33 768 *für weitere Einzelheiten*

Fotovervielfacher

Mullard Ltd, Mullard House, Torrington Place, London, W.C.1

(Abbildung Seite 328)

Anfang vorigen Jahres kündigte Mullard den Fotovervielfacher 56AVP an, dessen hohe Bildauflösung und Empfindlichkeitsspitze bei 4200 Å besonders wichtig für Verwendung mit Szintillationszählern ist, die hohe Zeitauflösung erfordern.

Jetzt wird eine Weiterentwicklung bekanntgegeben, nach der diese Röhre für Verwendung mit Gasszintillationszählern mit einem Quarz-Stirnfenster ausgestattet wird. Die neue Type 56UVP ist der 56AVP sehr änlich, hat aber eine Spektralempfindlichkeit, die weit in den ultravioletten Bereich ausgedehnt ist. Die nutzbare Empfindlichkeit geht bis zu 2300 Å herunter und hat eine Spitze bei 4000 Å (0,4 μm).

Für Arbeiten mit hoher Auflösung sind sehr kleine Elektronenlaufzeitunterschiede erforderlich, die im 56UPV bei Halbimpulshöhe nicht mehr als 2,0 ns betragen. Die Anstiegszeit hat dieselbe Dauer.

Die wesentliche Herabsetzung der Laufzeitunterschiede ist auf die Konstruktion des elektronenoptischen Eingangssystems zurückzuführen, in dem die Fotokathode so gewölbt ist, dass der Weg für die einen beliebigen Punkt der Netzfläche zur ersten Vervielfacherstufe verlassenden Elektronen näherungsweise gleichlang ist. Tatsächlich ist der Laufzeitunterschied zwischen Elektronen, die vom Umfang der ersten Fotokathode auf der ersten Dynode ankommen und Elektronen, die von der Mitte ankommen, nur 0,3 ns.

Durch sorgfältige Formgebung der Dynoden in den 14 Vervielfacherstufen und durch zusätzliche Fokussierelektroden zwischen jeder Vervielfacherstufe, die trotz schnell anwachsender Elektronenzahl den Strahl von Stufe zu Stufe fortschrittlich einengen, wird die Laufzeit gleichmässig gehalten.

EE 33 769 *für weitere Einzelheiten*

Vidikon-Aufnahmeröhre

English Electric Valve Co. Ltd, Chelmsford, Essex

(Abbildung Seite 328)

English Electric Valve Co. Ltd hat die Vidikon-Aufnahmeröhre 7038 eingeführt, um der wachsenden Mannigfaltigkeit der Vidikon-Verwendung gerecht zu werden. Die Konstruktion dieser Röhre ist umfangreich genug, um Einsatz für Filmabtastung, Studiosendungen und industrielle Zwecke zu ermöglichen, für die bisher mehrere Spezialröhren benutzt wurden. Kleine Abmessungen und Einfachheit erleichtern Konstruktion und Betrieb der Kamera und zugehörigen Geräte, die, mit Anlagen für kompliziertere Aufnahmeröhren verglichen, äusserst kompakt sind. Das ist besonders wertvoll in 3-Röhren-Farbkameras und Industriekameras, für die kleine Abmessungen erforderlich sind.

In der Mitte der Stirnfläche hat die 7038 ein Auflösungsvermögen von ungefähr 600 Zeilen. Eine gleichmässige lichtleitende Schicht wird als lichtempfindliches Element benutzt, das durch einen praktisch panchromatischen Frequenzgang gekennzeichnet ist, wodurch Fleischfarbtöne getreu wiedergegeben werden und ein anderen Aufnahmeröhren ähnliches Bild entsteht. Die Empfindlichkeit der 7038 ermöglicht Direktaufnahme von Szenen bei auffallender Beleuchtung von 1000 bis 2000 Lux mit einer Objektivöffnung von f/2,8 ... f/4,0. Für Fernsehbildqualität wird für Direktaufnahme in den hellsten Bildpunkten eine Schirmträgerbeleuchtung von 60 ... 150 Lux und für Filmabtastung von 1000 Lux empfohlen. Unter diesen Betriebsbedingungen ist die Verschmierung vernachlässigbar klein, und die Bildgleichförmigkeit entspricht dem höchsten Standard. Für Industriezwecke kann diese hochempfindliche Röhre mit 20 Lux Schirmträgerbeleuchtung bei nur geringer Verschlechterung der anderen Parameter benutzt werden.

EE 33 770 *für weitere Einzelheiten*

Stabilisierte Netzgeräte

Fraser Speller Transformers Ltd, Sydenham Road, Sydenham, London, S.E.26

(Abbildung Seite 328)

Diese Geräte sind für Verwendung auf dem Messtisch oder Einbau in andere Geräte geeignet. Die Schaltung arbeitet ohne Drossel unter Benutzung von Elektrolytkondensatoren, wodurch das Gerät kompakt und verhältnismässig leicht ist. Standardgeräte sind für Ausgangsspannungen von ±150, 200, 250 und 300 V bei 0 ... 100 mA, Geräte für andere Spannungen auf Bestellung lieferbar. Zwei Wechselspannungen von 6,3 V, 3 A sind auch vorgesehen. Die Stabilität der Ausgangsspannung liegt bei 0,06%, und effektive Restwelligkeit ist geringer als 2 mV. Der effektive Quellenwiderstand ist unter 0,1Ω und der Ausgangswiderstand für alle Frequenzen unter 2Ω.

EE 33 771 *für weitere Einzelheiten*

Transistorisierter Zerhackermodulator

Telephone Manufacturing Co. Ltd, Martell Road, West Dulwich, London, S.E.21

(Abbildung Seite 329)

Modell SM10 ist ein kleiner, hochkonstanter, mit Si-Transistoren bestückter Zerhacker, der zur Zerhackung niedriger Gleichspannungen ausgelegt ist. Er ist direkt gekoppelt und bietet dem Konstrukteur einen Blockierzerhacker einfacher Form. Er hat eine eingebaute Wellenformerschaltung, kann von jeder 6 V sinus- oder rechteckwellenförmigen Quelle im Frequenzbereich 40 Hz ... 1 kHz betrieben werden und schaltet zu zerhackende Spannungen von 1 μV ... 250 mV.

Sorgfältig ausgesuchte und angepasste Bauelemente geben dem Gerät niedrige Drift und praktisch unendliche Lebensdauer. Da alle Bauelemente in einem Aluminiumbecher eingekapselt sind, ist der Baustein praktisch unempfindlich gegen Schwingungen und Stosseinwirkung. Im Gegensatz zu mechanischen Zerhackern hat er keine der Abnutzung unterliegenden beweglichen Teile oder Kontakte, die verschmutzen können und benötigt keinerlei Justierung. Ausserdem ist er über einen grossen Temperaturbereich hochkonstant.

EE 33 772 *für weitere Einzelheiten*

Miniatur-Summenkreisel

Ketay Ltd, Eddes House, Eastern Avenue West, Romford, Essex

(Abbildung Seite 329)

Ein neuer Summenkreisel Type RI-203 wurde vor kurzem von der Norden Division der United Aircraft Corporation eingeführt und ist jetzt in England durch Ketay Ltd. erhältlich.

Dieser Präzisionskreisel wird u.a. in der Trägheitsnavigation und in Lenksystemen für Flugkörper und Flugzeuge, in der Stabilisation von Bordanlagen in Schiffen und überall dort Verwendung finden, wo genaue dynamische Winkelmessungen erforderlich sind.

Eingenschaften des neuen Kreisels umfassen die niedrige Abdriftrate - er hat eine regellose Abdrift von weniger als 0,02°/h, die ausgezeichnete tägliche Stabilität von 0,10°/m ohne Justierung— und die ungewöhnlich lange Lebensdauer von 3000 Stunden. Die niedrige Abdrift wurde mit einem Rotor erzielt, der nur mit 12 000 UPM läuft und durch diese Geschwindigkeit wesentlich zur langen Lebensdauer des Gerätes beiträgt.

Dieser Lenkkreisel ist bei einem Durchmesser von 50,8 mm nur 78,75 mm lang und wiegt mit Heizung und Abschirmung nur 450 g.

EE 33 773 *für weitere Einzelheiten*

UKW-Signalgeber

R.E.E. Telecommunications Ltd, 15a Market Square, Crewkerne, Somerset

(Abbildung Seite 329)

Dieser tragbare Signalgeber ist volltransistorisiert, hat gute Frequenzkonstanz und niedrige Streuung, so dass er besonders für die hohe Empfindlichkeit und den geringen Kanalabstand moderner UKW-Empfänger geeignet ist.

Der Frequenzbereich von 115...135 MHz wird überstrichen, und die Ausgangsspannung ist 0,1 μV...10 mV an 75Ω. Die HF-Streuung ist geringer als 0,2 μV und die Frequenzdrift während eines 10 min. Intervalls unter 5 kHz. Die Eichgenauigkeit ist 0,2%.

Das Gerät wird von internen Quecksilber-Batterien gespeist.

EE 33 774 *für weitere Einzelheiten*

Motorgetriebener Fernsehkanalschalter

The Plessey Co. Ltd, Vicarage Lane, Ilford, Essex

(Abbildung Seite 329)

Wir bedauern, dass auf Seite 254 unseres April-Heftes eine falsche Abbildung gezeigt wurde. Die richtige Abbildung erscheint in dieser Ausgabe. Im April-Heft wurde ein ZF-Miniaturübertrager gezeigt, der von der Wireless Telephone Co. Ltd, einer Schwesterfirma der Plessey Co. Ltd, hergestellt wird.

EE 33 775 *für weitere Einzelheiten*

Tragbarer Elektrokardiograf

New Electronic Products Ltd, 360 Kensington Road, London, S.E. 11

(Abbildung Seite 329)

Die Abmessungen dieses tragbaren Miniatur-Elektrokardiografen sind nur 228,6 × 101,6 × 101,6 mm. Das Gerät wiegt komplett mit Ledertragtasche nur 4 kg. Transistoren und gedruckte Schaltungen werden benutzt, und als Stromquelle dient eine aufladbare Batterie.

Das Diagramm ist während der Registrierung sichtbar, und zu den eingebauten Standardmerkmalen gehören wahlweise Schaltung aller Zuführungen und Normung auf 1 mV/cm mit Schalter für 2fache Dehnung.

Der Schreibstreifen ist über 15 m lang und 40 mm breit. Geschwindigkeiten von 50 mm/s, 25 mm/s und 5 mm/s sind vorgesehen. Registrieren erfolgt mit einem beheizten Schreibstift; ein Mikroschalter ändert die Styluswärme entsprechend der gewählten Geschwindigkeit.

Der Eingangswiderstand ist besser als 1 MΩ, und der Frequenzgang liegt von Gleichstrom bis zu 70 Hz innerhalb ±3 dB.

EE 33 776 *für weitere Einzelheiten*

Schutzrohrkontaktrelais

B & R Relays Ltd, Temple Fields, Harlow, Essex

(Abbildung Seite 329)

B & R Relays haben jetzt zwei Schutzrohrkontaktrelais in Produktion. Einer der Hauptvorzüge der Schutzrohrkontaktkonstruktion ist die erreichbare Schaltzahl: 20×10^6 Schaltungen bei maximaler Nennbelastung. Der nur 0,030Ω betragende Kontaktwiderstand ist auch sehr interessant. Die neuen Relais sind in Einsteckausführung. Type R01 hat einen 8-Stecker-Sockel und kann bis zu drei Schutzrohrkontakte aufnehmen. Type R02 hat mit Ausnahme des 14-Stecker-Sockels dieselben Abmessungen, ist aber für 4, 5 oder 6 Schutzrohrkontakte ausgelegt. Beide Relais sind für Gleichstrombetrieb, haben einen Durchmesser von 35 mm und sind ungefähr 82,5 mm hoch. Die Nennbetriebsleistung für einen Kontakt ist 0,1 W bis zu 0,9 W für 6 Kontakte.

EE 33 777 *für weitere Einzelheiten*

Zusammenfassung der wichtigsten Beiträge

Ein Leser für Dokumente mit handschriftlichen Vermerken von C. M. B. Reid

Zusammenfassung des Beitrages auf Seite 274-278

Die Konstruktion einer einfachen Maschine zum Lesen von Dokumenten mit handschriftlichen Vermerken, wie z.B. Rechnungen, wird beschrieben. Gründe, die zur Bearbeitung des Projektes führten, werden umrissen und die der Abtastung von handschriftlichen Zeichen eigenen Probleme aufgezeigt. Die mechanische und optische Konstruktion des Lesers wird kurz angegeben und die logischen Operationen genau beschrieben, durch die die Information des Dokumentes abgetastet, parallel gespeichert, verarbeitet und in einen Lochstreifen gestanzt wird. Ein eingebautes Warnsystem vermindert die durch Falten und Schmutz entstehende Fehlergefahr. Ihre Wirksamkeit wird in einer Zusammenfassung betriebsmässiger Resultate klargestellt.

ACORN—ein automatisches Startüberprüfungs- und Registriernetzwerk von R. Mansey

Zusammenfassung des Beitrages auf Seite 284-291

Der Beitrag beschreibt eine bestehende automatische Startüberprüfungsanlage, die für ein Flugkörpersystem entwickelt wurde, sich aber für jedes Flugzeug- und ähnliches System, dessen Parameter vorwiegend elektrisch sind, als geeignet erwiesen hat.

Die Methode zur Aufnahme der Eingangssignale sowie ihre Auswahl und ihr Vergleich mit Normalmassen wird besprochen. Die Konstruktion eines einzigartigen selbstabgleichenden Potentiometers wird beschrieben, und es wird gezeigt, wie der normalisierte Eingang benutzt wird, um einen Zweirichtungs-Treppenspannungsgenerator zu steuern, bis zwischen der Treppenausgangsspannung und der Eingangsspannung Parität besteht.

Der Beitrag schliesst mit einer kurzen Zusammenfassung der Verwendung des Gerätes zur Startüberprüfung von Flugzeugen.

Ein Drehmomentmesser für Fräsversuche von J. L. Gwyther

Zusammenfassung des Beitrages auf Seite 292-295

Ein Drehmomentmesser zur Ermittlung des Fräsdrehmomentes an einer Fräsmaschine wird beschrieben. Ein Geber der Differentialtransformatortype wird benutzt, und ein für Schreiber oder Sichtanzeige am Oszillografen geeignetes Ausgangssignal ist vorgesehen.

Ein Transistor-Multivibrator von B. D. Rakovich

Zusammenfassung des Beitrages auf Seite 303-305

Ein emittergekoppelter, selbstschwingender Multivibrator wird beschrieben. Die Dauer des quasistabilen Zustandes wird durch Laden und Entladen eines Kondensators gesteuert. Diese Schaltung eignet sich besonders zur Erzeugung symmetrischer und unsymmetrischer Rechteckwellenformen mit kurzem Übergang von einem stabilen Zustand in den anderen. Eine weitere gute Eigenschaft dieser Schaltung ist, dass sie auf sehr niedrigen Frequenzen Rechteckimpulse ziemlich guter Form erzeugen kann.

Ein verbesserter Spannungskonstanthalter von A. K. Chatterjee, K. V. Ramanan und B. S. Rao

Zusammenfassung des Beitrages auf Seite 308-311

In einem Spannungskonstanthalter mit gegengekoppelter Verstärkung werden in der Nebenregelschaltung oft zwei Gleichspannungsverstärkerstufen verwendet, um die Stabilisation in Bezug auf die Schwankungen der Ausgangsspannung zu verbessern. Im vorliegenden Beitrag wird gezeigt, dass eine am Schutzgitter der zweiten Röhre im Gleichspannungsverstärker angelegte Eingangskompensation in Bezug auf die Eingangsspannungsschwankungen eine sehr hohe Stabilisation hervorruft. Konstruktionseinflüsse und die Leistungsverbesserung des Konstanthalters mit Eingangskompensation werden besprochen.

Anpassungsfähige Verstärker mit Gegenkopplung für Rechner, Labors und Industrie*

* *Referat von P. G. Kendall nach einem Original-Bericht von J. Miedzinski und S. A. Patel*

Zusammenfassung des Beitrages auf Seite 312-316

Im Zusammenhang mit Entwicklung und Konstruktion des Netzwerkanalysators der Electrical Research Association wurden Versuche an elektronischen Verstärkern ausgeführt, die ergaben, dass die Lagerhaltung genormter Bausteine in wenigen Typen zweckdienlich ist und zu Ersparnissen führt.

Die Konstruktion solcher Bausteine wird eingehend diskutiert. Ein methodisches Verfahren für ihre Verwendung zur Befriedigung vorgegebener Bedingungen wird beschrieben und durch ein Beispiel erläutert.

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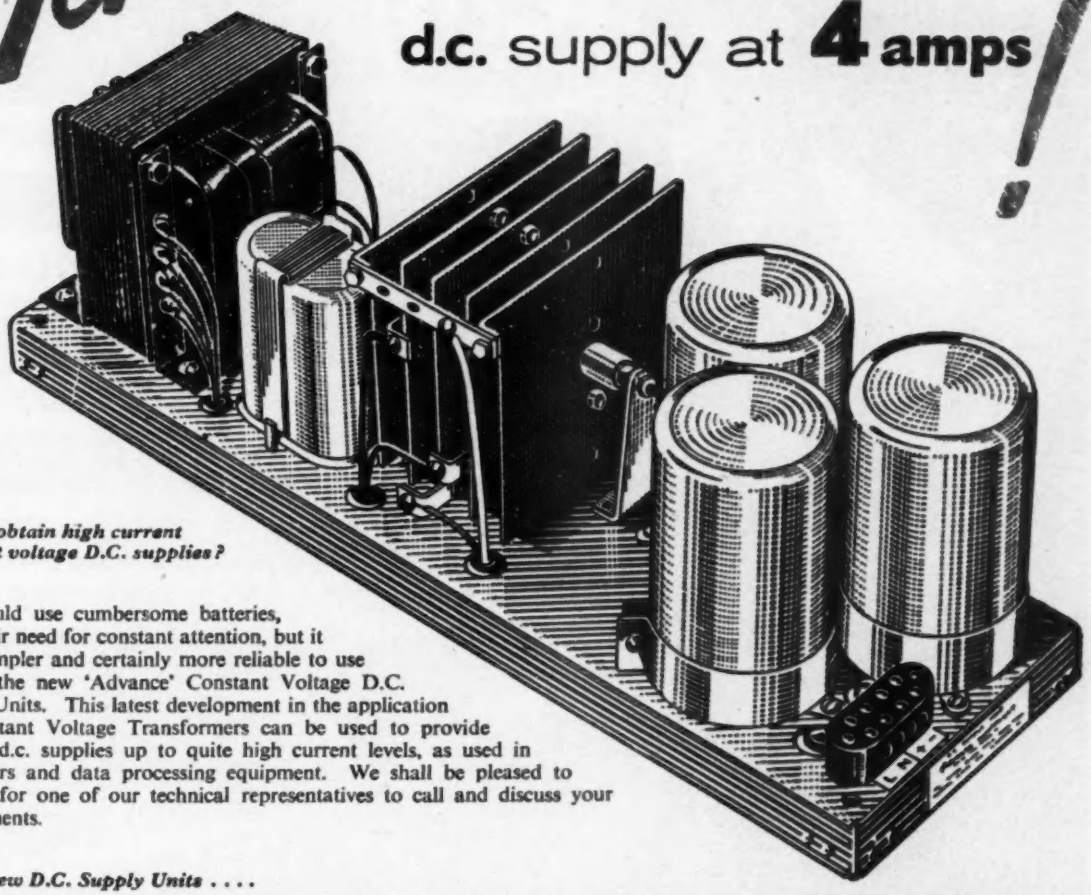

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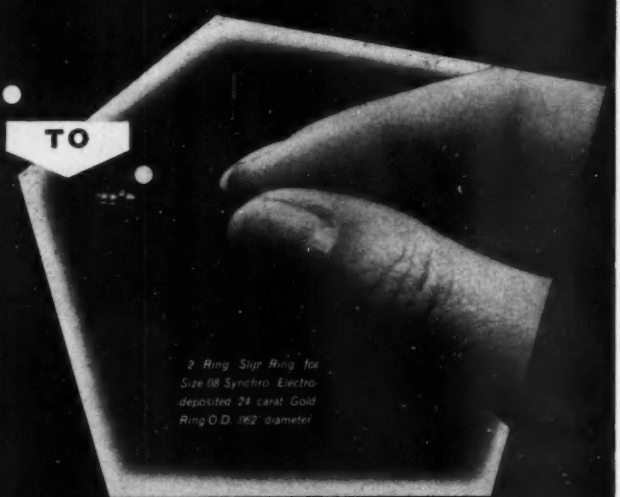

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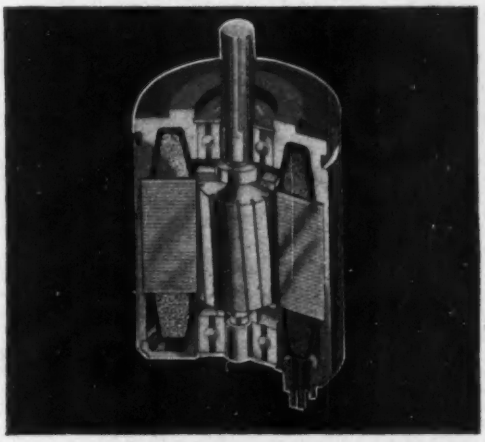

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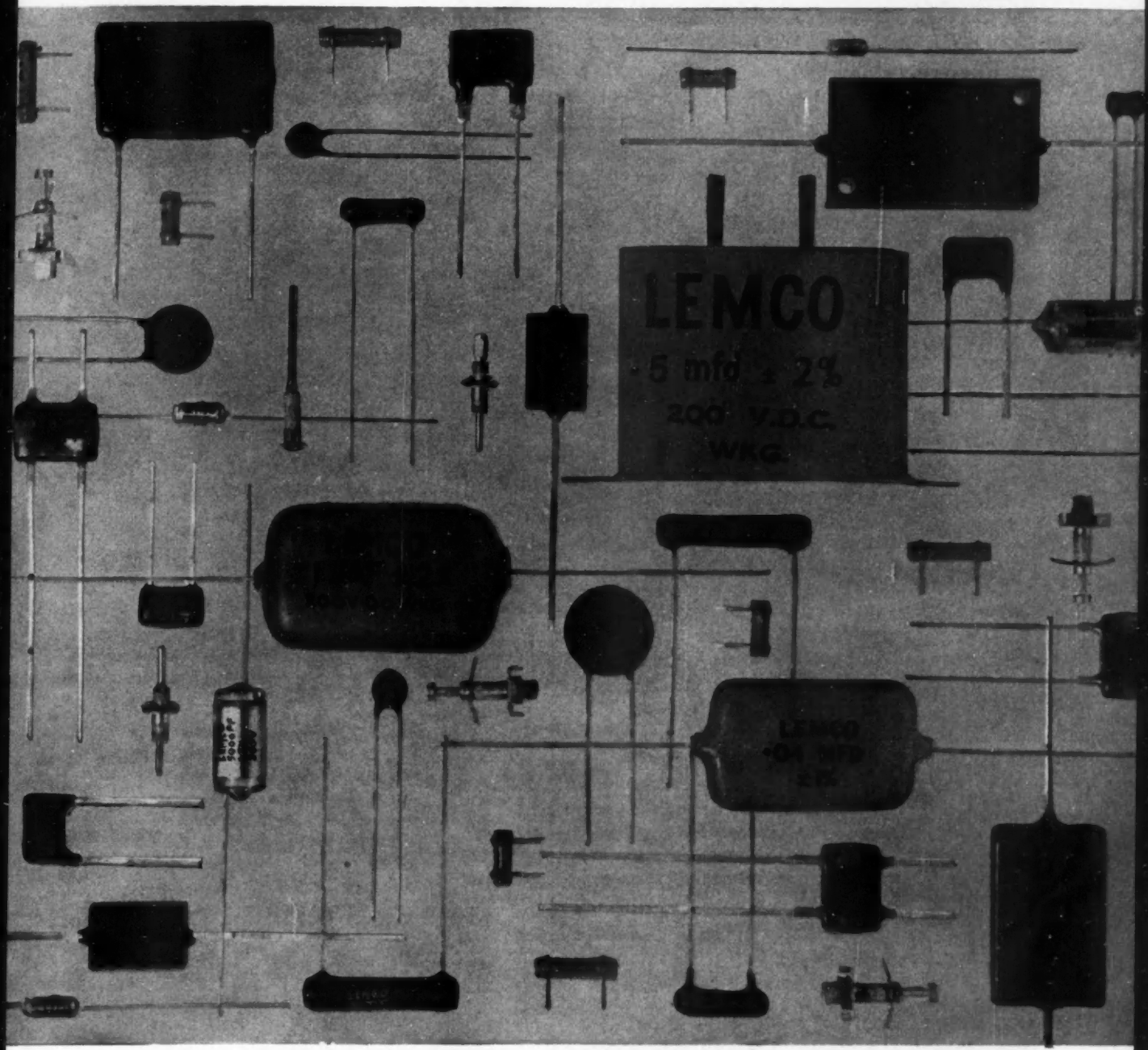

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London Electrical Manufacturing Company Limited
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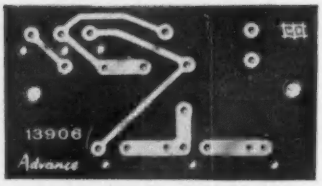
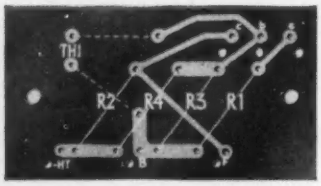
FOR PRINTED CIRCUITS AND COMPONENTS

TWO-FACED CIRCUITS



Printed circuit panel—copper side.



Reverse side with component detail and circuit replica colour printed.

Makes fault location easy. Developed and patented by Mills & Rockleys, the two-faced circuit speeds assembly, and reduces errors in production. One side of the laminate is a normal printed circuit. On the other side, the circuit is colour printed in reverse, together with positions of components to be wired in.

TGA PS3

M R

TECHNICAL DESIGN SERVICE

gets *your* circuit ideas into print

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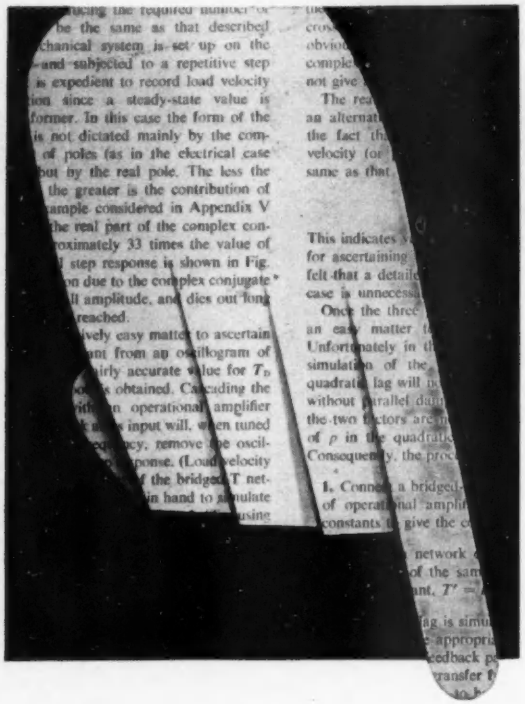
Swan Lane, Coventry. Phone Coventry 26222-3



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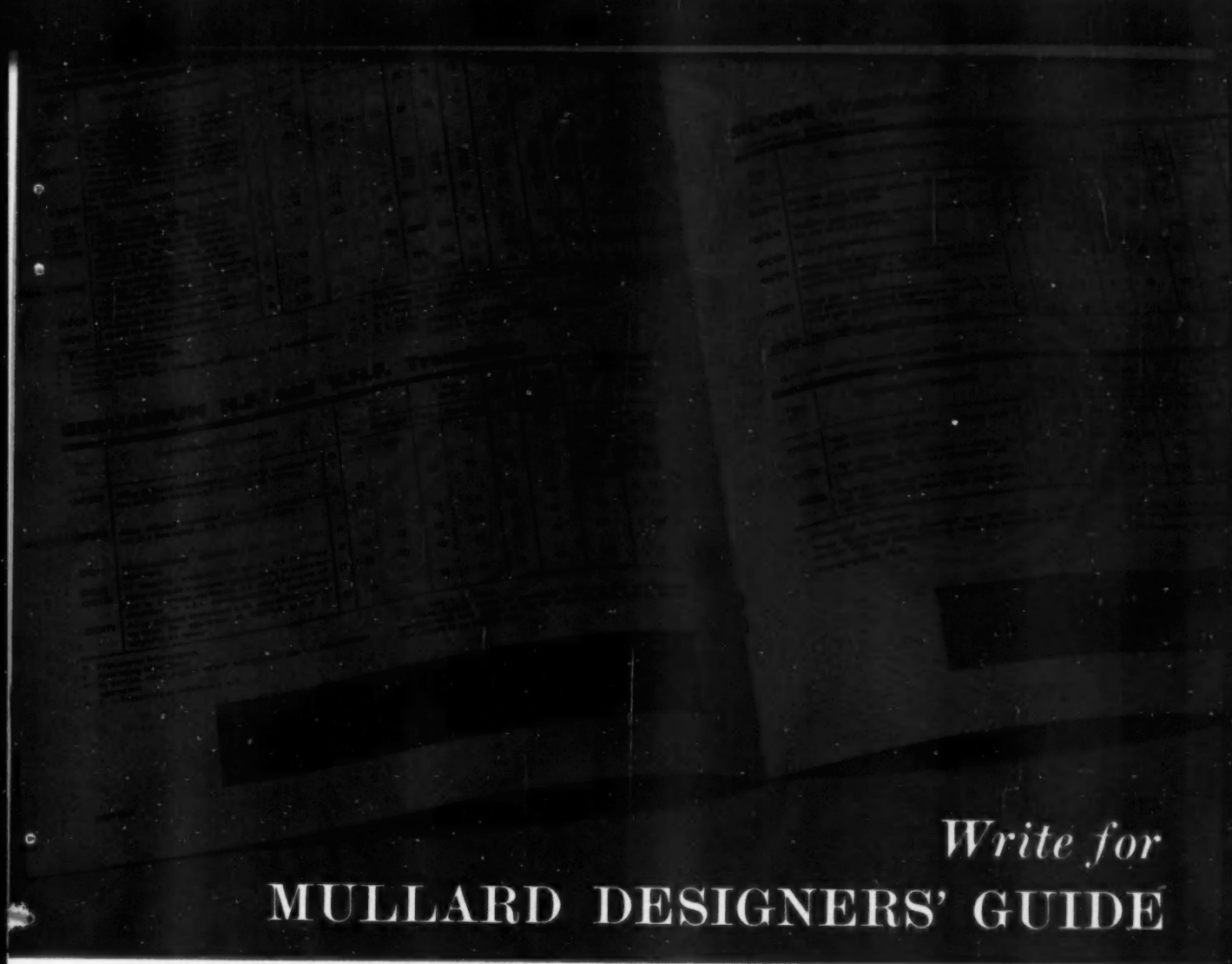
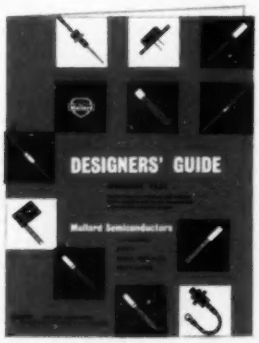


Write for

MULLARD DESIGNERS' GUIDE

a quick and easy reference for all semiconductor users



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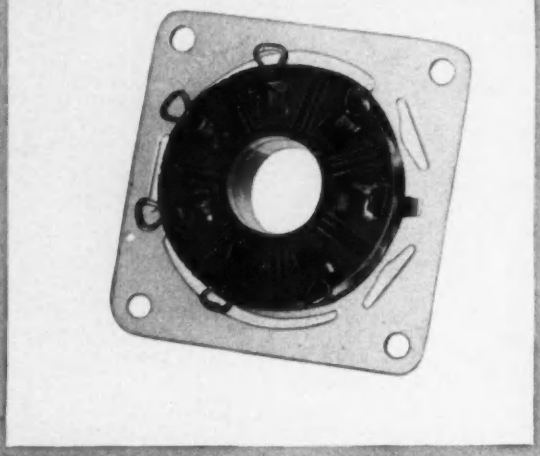

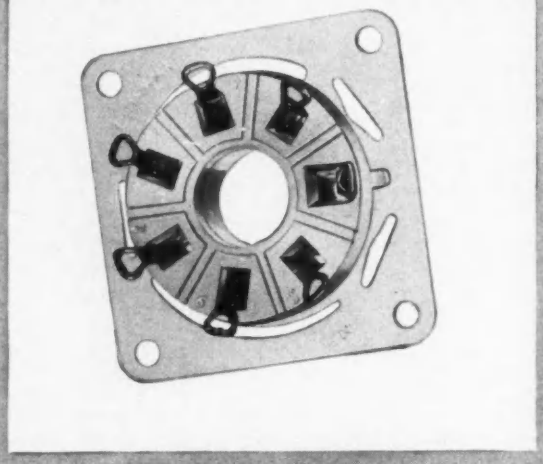

Body Moulding	PTFE	Nylon Phenolic
Catalogue No.	VH 127/7	VH 117/7
Contacts	Beryllium Copper—Silver plated	
Tags	Pre-soldered	
Saddle	Brass—Silver plated (CCA No. 5935-99-056-0103) Brass—cadmium plated (CCA No. 5935-99-056-0096)	Brass—cadmium plated (Quality approved) Brass—Silver plated

B7A VALVEHOLDER IN PTFE OR NYLON PHENOLIC

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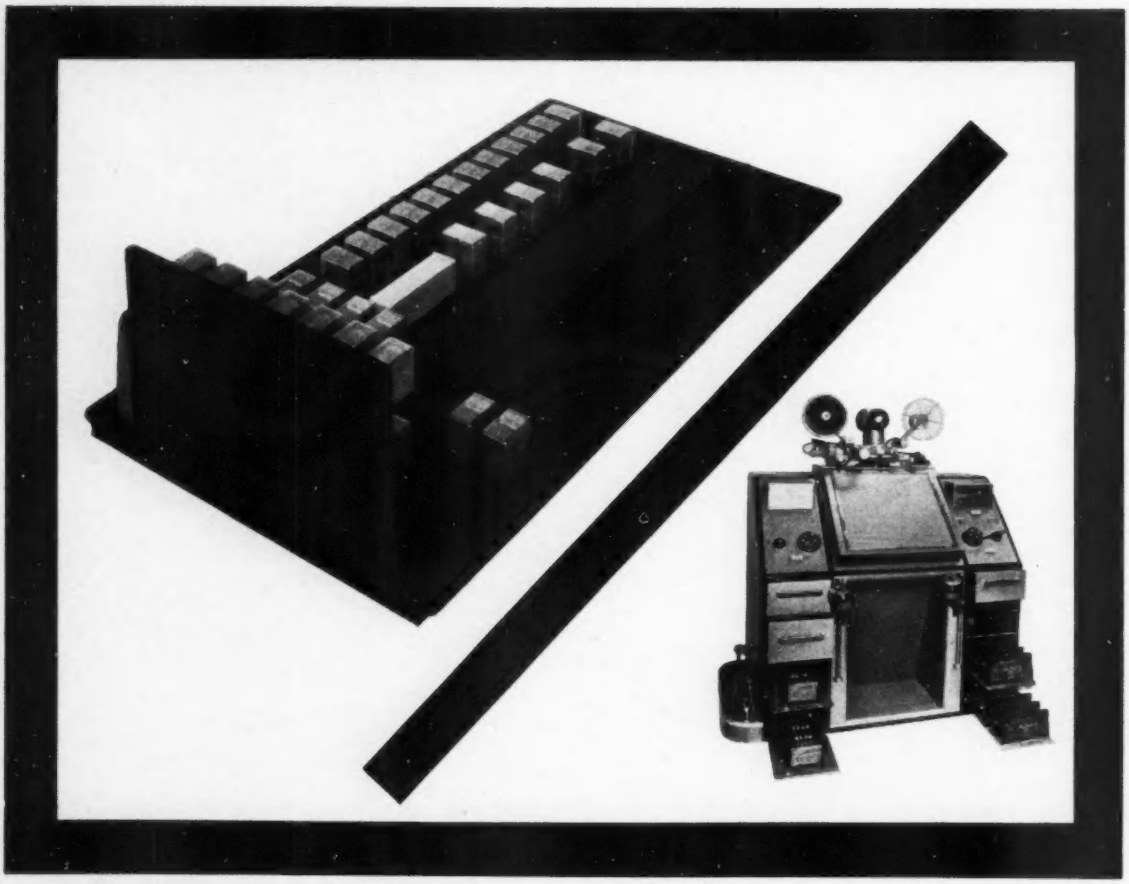

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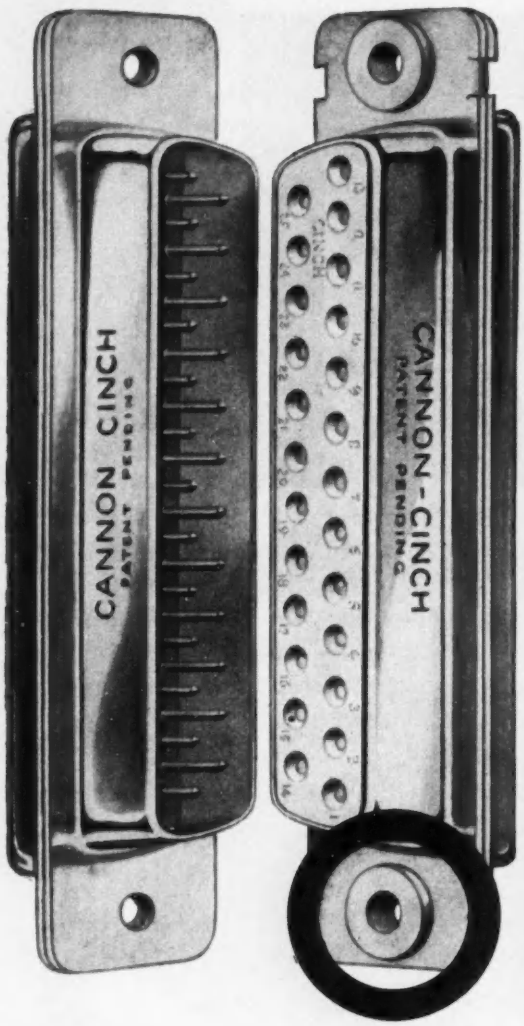

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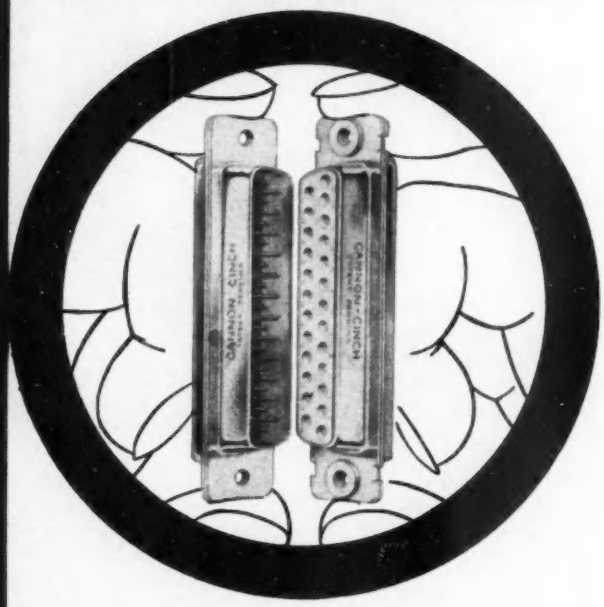

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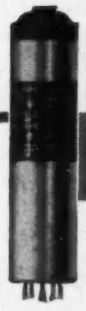
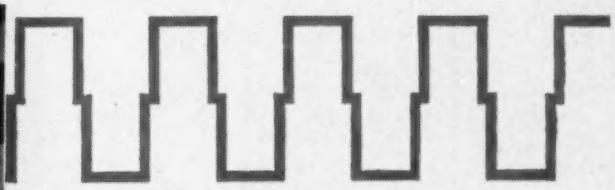
AEI SYNCHRONOUS CHOPPER TYPE CK3

The AEI synchronous chopper is intended for chopping direct current from low power signal sources to alternating current of mains frequency, usually as a preliminary to a.c. amplification. It is suitable for both high-resistance and low-impedance transformer circuits. The type CK3 is widely used in such applications as the chopping of thermo-couple signals in temperature recorders and drift correction in analogue computer amplifiers.





The synchronous chopper type CK3 consists of a miniature contact assembly, actuated by a coil-driven reed vibrating at mains frequency (50 or 60 c/s). It fits a standard 9 pin thermionic valve holder type B9A and is available with either a 6.3 volt or 12.6 volt a.c. driving coil. A 100 c/s tuned version is also available.

For further information write to:
AEI Instrumentation Division,
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Trafford Park, Manchester, 17.

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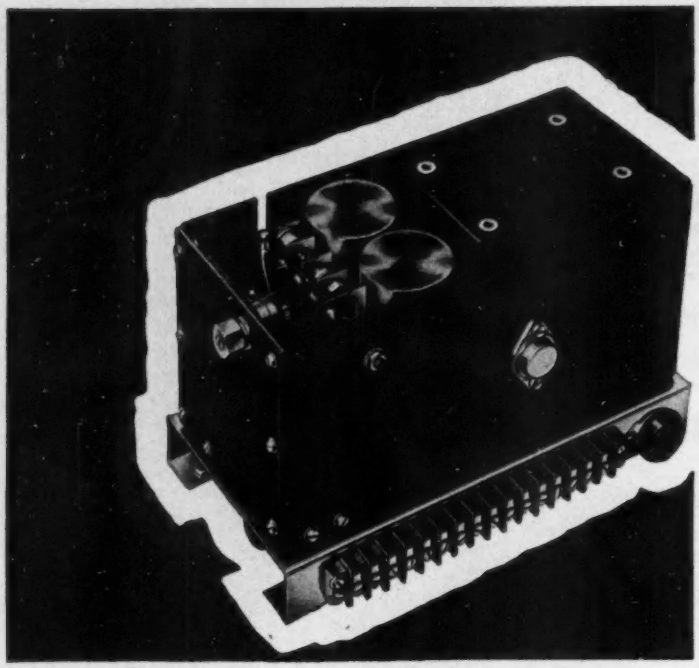
CHOOSE BELIX



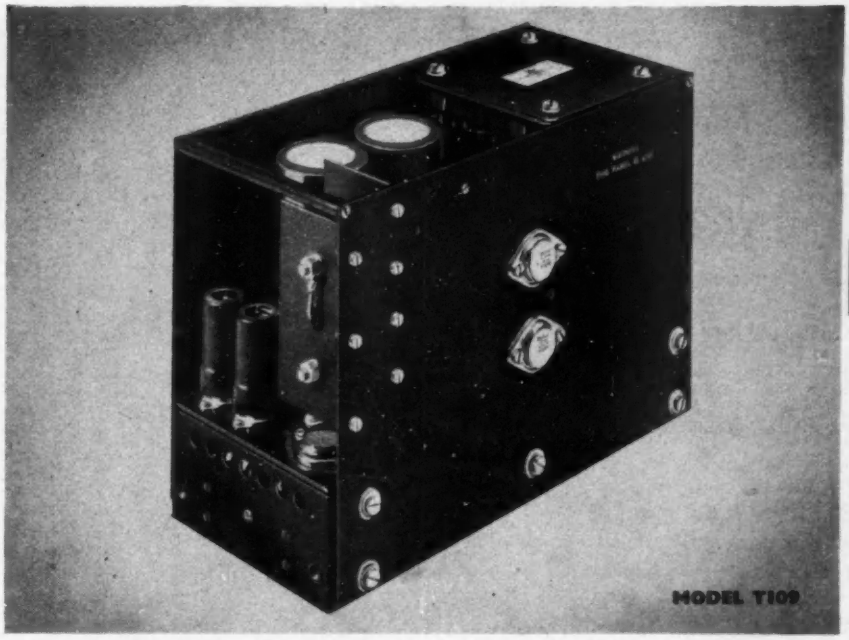
CHOOSE BELIX TRANSISTOR POWER SUB-UNITS

THE BELIX COMPANY LIMITED • VICTORIA ROAD SURBITON SURREY • ELM 9118

TYPE No.	TSS 61	TSS 62	TSS 63	TSS 300	TSS 04	TSS 14	TSS 24	TSS 34	TSS 44	TSS 241	TSS 114	TSS 104	TSS 94	TSS 84	TSS 74	TSS 121	TSS 122	TSS 123	TSS 124	TSS 125	TSS 51	TSS 52	TSS 53	TSS 54	TSS 55
OUTPUT *d.c. volts:*	0-12	0-12	0-12	⊛ 0-24	0-6	6-14	12-20	16-24	20-30	* 0-24	0-6	6 14	12-20	16-24	22-30	0-6	6-12	12-20	16-24	20-30	0-6	6-12	12-20	16-24	20-30
OUTPUT *amps (max.):*	0·1	0·3	0·5	1·0	1·0	1·0	1·0	1·0	1·0	1·0	2·0	2·0	2·0	2·0	2·0	6·0	6·0	6·0	6·0	6·0	10·0	10·0	10·0	10·0	10·0
STABILITY RATIO *(7% mains)*	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1
SOURCE RESISTANCE Ω *less than:*	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0 01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01
A.C. IMPEDANCE Ω *(max.) to 200 kc/s:*	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15
RIPPLE *(pk-pk) mV less than:*	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0

* *Provides two independent outputs.* ⊛ *Available as plug-in or wire-in sub-unit. TSS 61, 62, 63 are continuously variable; all other units have coarse step plus fine adjust facility.*

belix



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The Roband philosophy of power supplies is to provide *exactly* your *specific* requirements in units of lasting reliability. Roband probably manufacture the widest and most comprehensive range of power supplies available anywhere today. Unrivalled Roband reliability is built into the power supplies by unstinted use of high grade components, interservices approved wherever practical, and by consistently underrunning them – transistors for example at never more than 50% of manufacturers' ratings. Painstaking Roband engineering ensures ample ventilation and mechanical strength for the severest conditions.

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Open chassis units are supplied pre-set to any voltage from zero nominal (the T98 starts at 6v) to maximum, a pre-set control allowing a small variation. Any other voltage can be obtained by simple adjustment within the unit.

MODEL	D.C. OUTPUT (FLOATING) VOLTS	AMPS	EFFECTIVE RESISTANCE Ω	% VOLTAGE STABILITY	RIPPLE IN mV	SIZE IN INCHES L X D X HT	WEIGHT IN LBS.	EX-WORKS £ S. D.
T SERIES OPEN CHASSIS PRE-SET VOLTAGE UNITS (Mains 200/250V A.C. 100/125V models also available)								
T98	6–18	0·5	0·08	0·1	1·0	5½ 2¾ 4⅞	3¾	32 0 0
T100	30 max.	1·0	0·04	0·1	1·0	7¼ 4½ 5¾	5½	45 0 0
T108	50 max.	1·0	0·1	0·1	1·0	8½ 5½ 6¼	8	55 0 0
T109	50 max.	2·0	0·05	0·1	1·0	10¾ 5½ 7¼	13	70 0 0
T110	30 max.	5·0	0·01	0·1	1·0	13½ 8½ 7¾	23	98 0 0
T114	30 max.	10·0	0·01	0·1	1·0	17 10 8½	39	135 0 0

Please order as follows: Type No./Voltage required. For example: T109/45 is a 45 volt 2A unit.

T SERIES FRONT PANEL VARIABLE UNITS (Mains 200/250V A.C. 100/125V models also available)									
T99	0–30	0·5	0·1	0·1	1·0	9¾ 5½ 5	8	64 10 0
T101	0–50	1·0	0·1	0·1	1·0	13½ 10½ 9¾	19½	93 0 0
T102	0–30	2·0	0·05	0·1	1·0	16¾ 10½ 10¾	30	100 0 0
T103	0–30	1·0	0·05	0·1	1·0	13½ 10½ 9¾	19½	85 0 0
†T104	0–30	1·0	0·05	0·1	1·0	16¾ 10½ 10¾	30	129 0 0
	0–30	1·0	0·05	0·1	1·0			
T105	0–50	2·0	0·05	0·1	1·0	16¾ 10½ 10¾	30	118 0 0
T106	0–100	1·0	0·1	0·1	2·0	*21½ 14½ 11¾	46	149 0 0
T107	0–100	2·0	0·1	0·1	2·0	*21½ 14½ 11¾	60	183 0 0
T111	0–50	5·0	0·01	0·1	2·0	*21½ 18½ 11¾	64	155 0 0
T112	0–50	10·0	0·01	0·1	2·0	*21½ 20½ 13¾	101	245 0 0
T113	0–30	20·0	0·01	0·1	2·0	*21½ 21 16¾	139	315 0 0

*Panel and chassis withdrawable to fit 19" rack. †Note that T104 has two independent floating sections.

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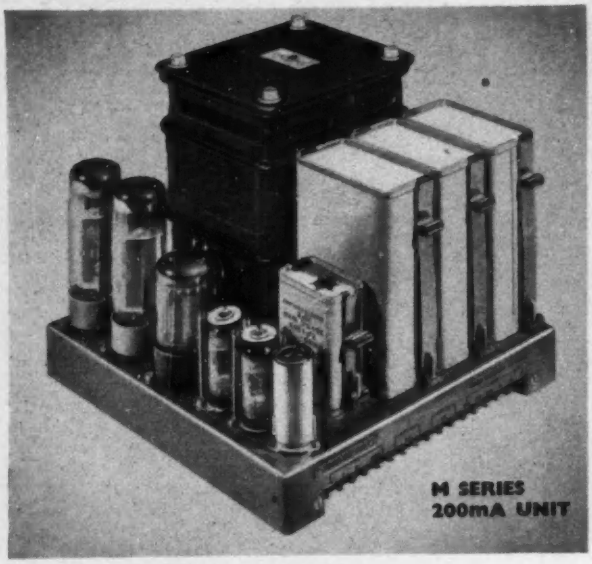
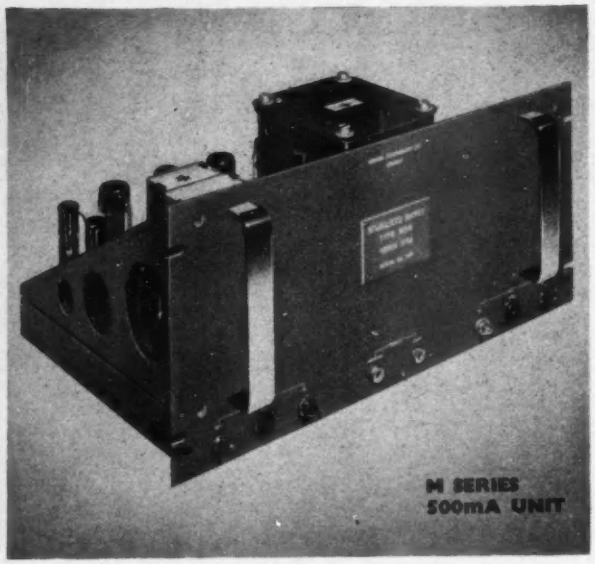




ROBAND

VACUUM TUBE REGULATED

MODEL	D.C. OUTPUT (FLOATING) VOLTS	mA	A.C. OUTPUTS IN AMPS. (ALL 6·3V)	EFFECTIVE RESISTANCE Ω	% VOLTAGE STABILITY	RIPPLE IN mV	SIZE IN INCHES L	X D	X HT.	WEIGHT IN LBS.	EX-WORKS £	S.	D.
M SERIES OPEN CHASSIS UNITS (Mains 200/250V A.C. 115V models also available)													
M22	150	0–20	Nil	0·1	0·02	1·0	4¾	3¾	4¾	2½	26	0	0
M22A	200	0–20	Nil	0·1	0·02	1·0	4¾	3¾	4¾	2½	26	0	0
M23	150	0–50	2 & 1	0·1	0·02	1·0	6	5½	5¾	6	27	10	0
M23A	200	0–50	2 & 1	0·1	0·02	1·0	6	5½	5¾	6	27	10	0
M33	250	0–50	2 & 1	0·1	0·02	1·0	6	5½	5¾	6	27	10	0
M33A	300	0–50	2 & 1	0·1	0·02	1·0	6	5½	5¾	6	27	10	0
M14A	100	0–100	3 & 3	1·0	0·02	1·0	10¾	7	6½	14½	63	0	0
M24	150	0–100	3 & 3	0·1	0·02	1·0	7¾	6¾	6½	12¾	33	10	0
M24A	200	0–100	3 & 3	0·1	0·02	1·0	7¾	6¾	6½	12¾	33	10	0
M34	250	0–100	3 & 3	0·1	0·02	1·0	7¾	6¾	6½	12¾	33	10	0
M34A	300	0–100	3 & 3	0·1	0·02	1·0	7¾	6¾	6½	12¾	33	10	0
M25	150	0–200	3 & 3	0·1	0·02	1·0	8¾	8½	7	20	52	10	0
M25A	200	0–200	3 & 3	0·1	0·02	1·0	8¾	8½	7	20	52	10	0
M35	250	0–200	3 & 3	0·1	0·02	1·0	8¾	8½	7	20	52	10	0
M35A	300	0–200	3 & 3	0·1	0·02	1·0	8¾	8½	7	20	52	10	0
M26S	150	30–500	5 & 5	0·1	0·02	1·0	14	11½	8	20	88	0	0
M26SA	200	0–500	5 & 5	0·1	0·02	1·0	14	11½	8	35½	88	0	0
M36S	250	0–500	5 & 5	0·1	0·02	1·0	14	11½	8	35½	88	0	0
M36SA	300	0–500	5 & 5	0·1	0·02	1·0	14	11½	8	35½	88	0	0
M28	150	30–350	5 & 5	0·1	0·02	1·0	13½	8¾	6¾	29	66	0	0
M28A	200	0–350	5 & 5	0·1	0·02	1·0	13½	8¾	6¾	29	66	0	0
M38	250	0–350	5 & 5	0·1	0·02	1·0	13½	8¾	6¾	29	66	0	0
M38A	300	0–350	5 & 5	0·1	0·02	1·0	13½	8¾	6¾	29	66	0	0
M SERIES FRONT PANEL UNITS (Mains 200/250V A.C. 115V models also available)													
M26	150	30–500	5 & 5	0·1	0·02	1·0	19	12	8¾	46½	97	10	0
M26A	200	0–500	5 & 5	0·1	0·02	1·0	19	12	8¾	46½	97	10	0
M36	250	0–500	5 & 5	0·1	0·02	1·0	19	12	8¾	46½	97	10	0
M36A	300	0–500	5 & 5	0·1	0·02	1·0	19	12	8¾	46½	97	10	0
M27	150	50–1·0A	5 & 5	0·1	0·02	1·0	19	15¾	8¾	50½	165	0	0
M27A	200	0–1·0A	5 & 5	0·1	0·02	1·0	19	15¾	8¾	50½	165	0	0
M37	250	0–1·0A	5 & 5	0·1	0·02	1·0	19	15¾	8¾	50½	165	0	0
M37A	300	0–1·0A	5 & 5	0·1	0·02	1·0	19	15¾	8¾	50½	165	0	0
M29	150	100–2·0A	5 & 5	0·1	0·C2	1·0	19	18	10½	82½	255	0	0
M29A	200	0–2·0A	5 & 5	0·1	0·02	1·0	19	18	10½	82½	255	0	0
M39	250	0–2·0A	5 & 5	0·1	0·02	1·0	19	18	10½	82½	255	0	0
M39A	300	0–2·0A	5 & 5	0·1	0·02	1·0	19	18	10½	82½	255	0	0

ALL C.T.

B SERIES

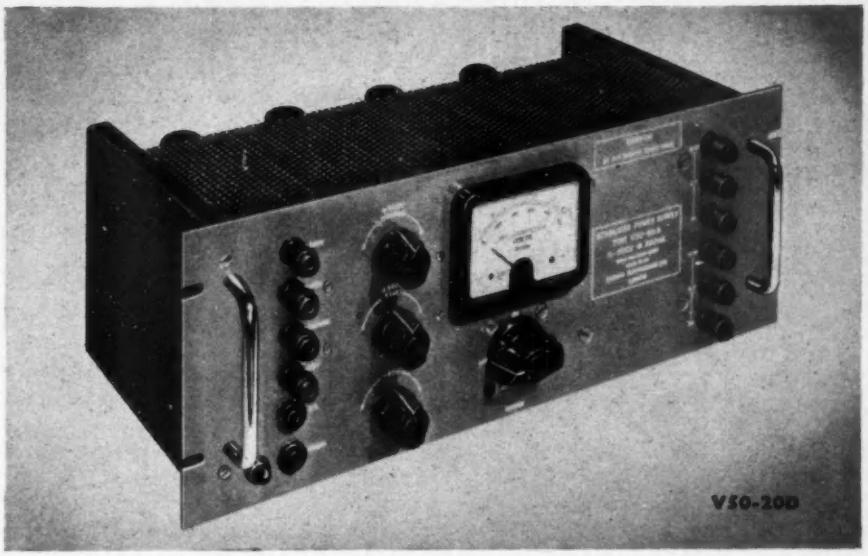
Rugged reliable units

Probably the most advanced series of open chassis units available today and characterised by an extremely rugged construction and a line-up of inter-services approved reliable valves. The input and outputs terminate on Plessey Mark 4 connectors (or any suitable alternative if requested) and a mains selector panel is included.

A compact welded rectangular framework of extruded angle aluminium alloy rigidly secures the 'C' core transformer and the 14 S.W.G. chassis housing the electronic sub-assembly. Because all the vulnerable components are located within the framework the risk of accidental damage is greatly minimised.

The framework contains anchor nuts which facilitate mounting the units in a variety of ways. It is permissible, for instance to secure any two units side by side to a standard 19" x 7" front panel.

High efficiency silicon junction rectifiers, series valves operating as pentodes and a 'C' core transformer to H2 specification ensure a minimum temperature rise within the unit. Insulated carbon and vitreous wire-wound resistors are used throughout and the conservative design permits continuous operation at full load even when the mains are permanently ±10% from nominal.



POWER SUPPLIES

ROBAND

MODEL	D.C. OUTPUT (FLOATING) VOLTS	mA	A.C. OUTPUTS IN AMPS. (ALL 6·3V)	EFFECTIVE RESISTANCE Ω	% VOLTAGE STABILITY	RIPPLE IN mV	SIZE IN INCHES L X D X HT.	WEIGHT IN LBS.	EX-WORKS £ S. D.
B SERIES RUGGED RELIABLE UNITS (Mains 200 250V A.C. & 100 125V A.C.)									
B101/150	150	30–150	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B101/200	200	0–150	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B101/250	250	0–150	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B101/300	300	0–150	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B101/350	350	0–100	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B102/150	150	30–300	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B102/200	200	0–300	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B102/250	250	0–250	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B102/300	300	0–250	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B102/350	350	0–200	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B103/150	150	30–500	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0
B103/200	200	0–500	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0
B103/250	250	0–500	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0
B103/300	300	0–500	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0
B103/350	350	0–400	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0

— ALL C.T.

M SERIES

Open chassis units

Since their introduction some years ago, these chokeless supplies have firmly established their superiority over more conventional circuits. Their smaller size—excellent high frequency performance and stable operation down to at least 1 c.p.s.—reliability at elevated temperatures and safe operation for ±10% mains changes—coupled with the highest engineering standards confirm the "M" Series as the first choice in stabilised units.

Front panel units

The front panel units have been designed for use with standard 19" racks. The panel is finished in B.S.S.632 grey (or any other colour at no extra cost) and houses the handles, mains and H.T. switches, fuses and indicator lamps. The input and outputs terminate on Plessey Mark 4 connectors (or any suitable alternative if requested) at the rear of the chassis.

V SERIES Regulated variable voltage units

A range of regulated variable voltage supplies for use on the bench or standard 19" racks. Minimum weight and low internal heat dissipation are obtained by using chokeless circuits, 'C' core transformers, silicon junction rectifiers and series valves operating as pentodes.

V50-50. An exceptionally stable decade controlled 0 to 500V 500mA unit. A fixed 250V 50mA negative rail and two 6.3V 5A centre tapped windings are included.

The decade system enables the output to be changed incrementally with a much greater accuracy than that obtained by normal methods.

Price £137-10-0 ex-works

V50-20D. A 0 to 500V 200mA unit (restricted to 150mA below 200V) of moderate performance. A regulated variable negative rail from 0 to 85V via a 100K potentiometer and two 6.3V5A centre tapped windings are included. A coarse control varies the output from 0 to 500V in one continuous sweep and a fine control is included.

Price £69-10-0 ex-works

2V35-25. A very compact unit containing several regulated output voltages. There are two 0 to 350V 250mA sections (restricted to 150mA below 200V) which may be operated separately, in parallel or in series. Each section has a coarse control to vary the output from 0 to 350V in one sweep and a fine control is included. A fixed 250V 50mA negative rail and two 6.3V5A centre tapped windings are provided.

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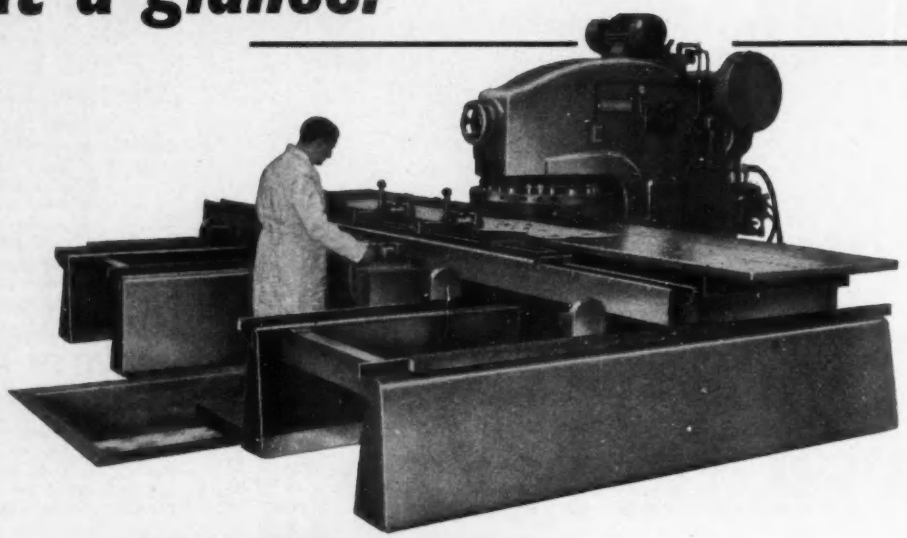

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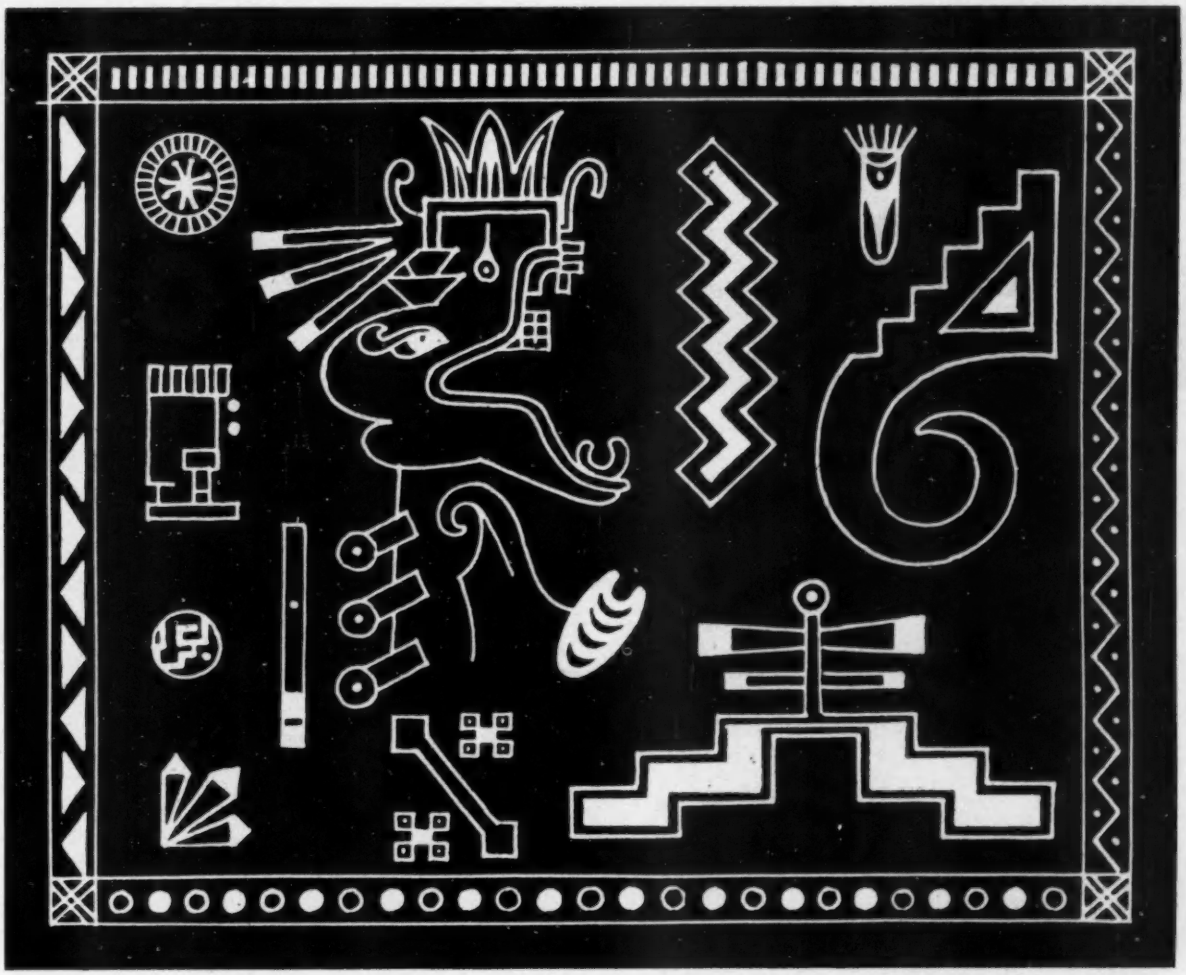

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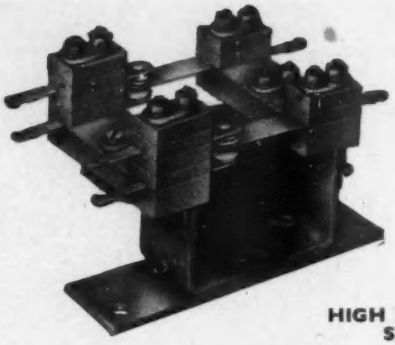
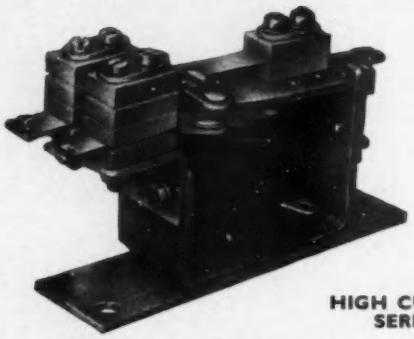


HIGH VOLTAGE SERIES



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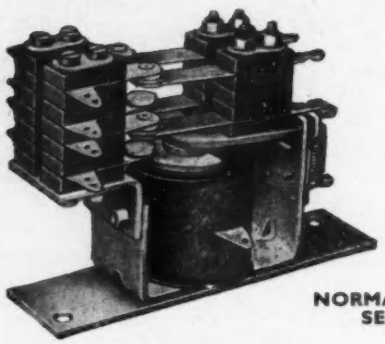

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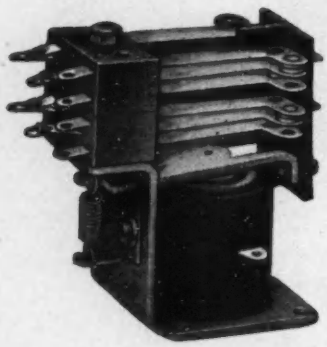

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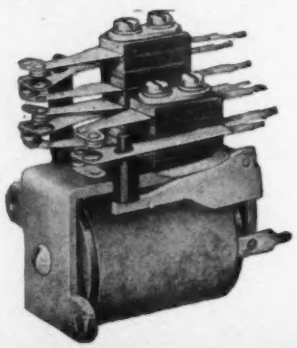

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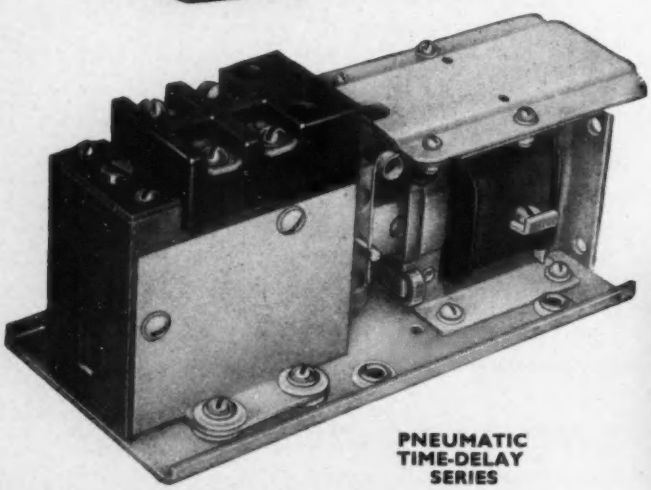

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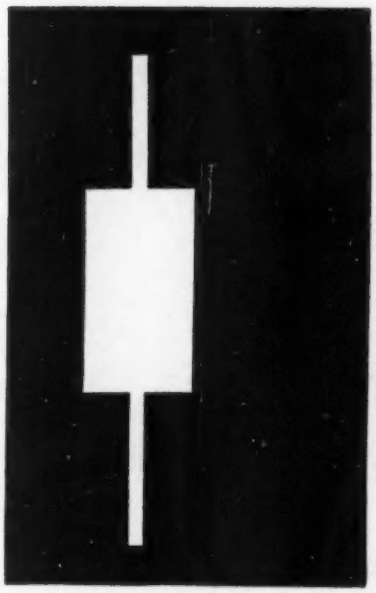

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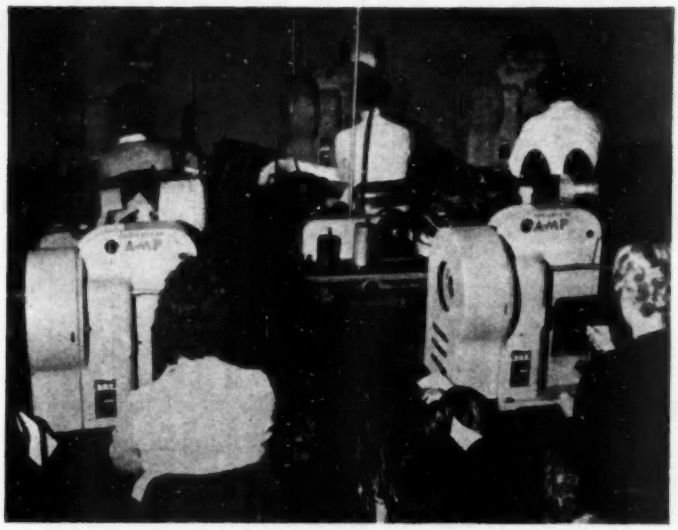

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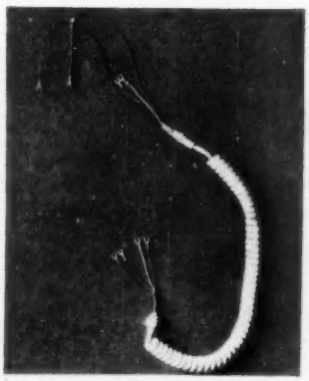

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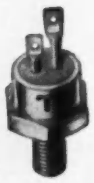

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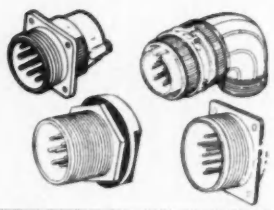

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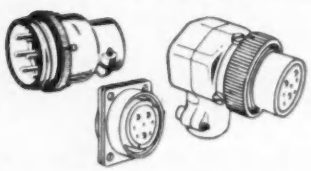

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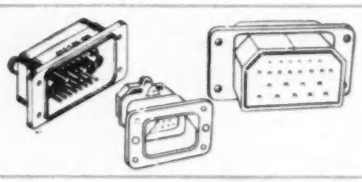

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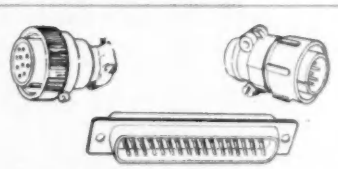

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COLLECTOR CURRENT	I_c	20	20	mA
CURRENT GAIN SPREAD	h_{FE}	20-55	45-150	—

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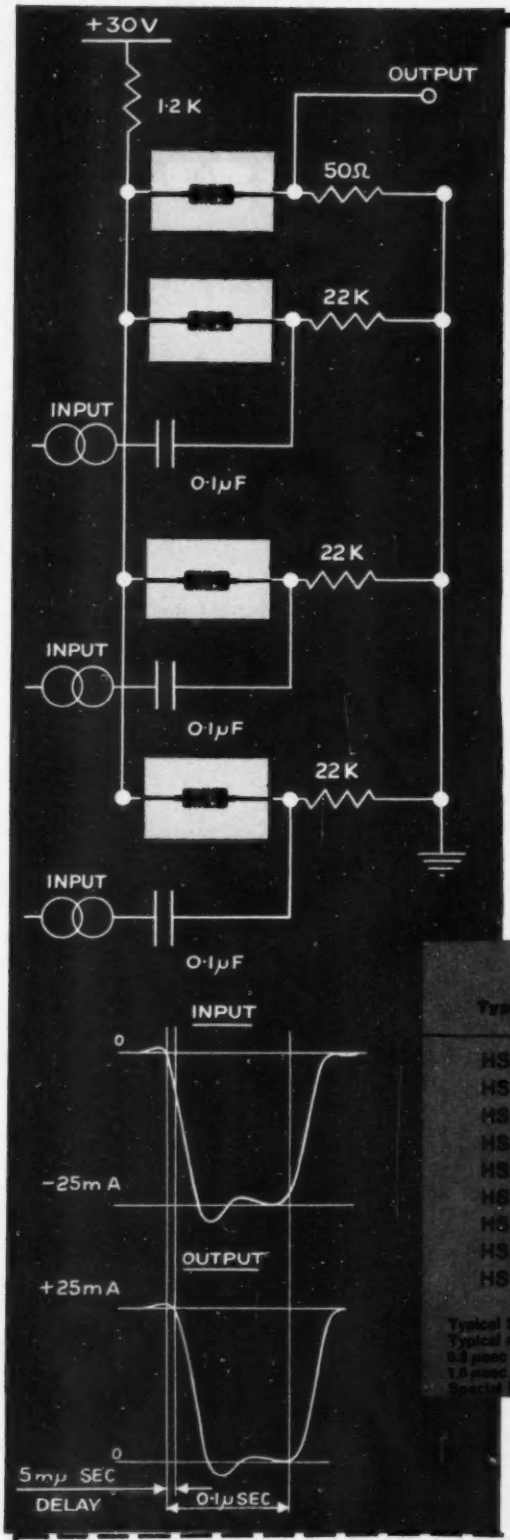


FOR HIGH PERFORMANCE COMPUTER CIRCUITS specify

fast recovery
silicon junction
low hole storage

diodes

STAND No. 499
MAY 30—JUNE 2
RECMF
EXHIBITION
OLYMPIA

Hughes HS11 series are alloyed junction silicon *computer* diodes, operative over wide temperature ranges and characterized by *fast recovery time.*

Made in Glenrothes, Scotland, the Hughes range of silicon and germanium diodes are subminiature devices with extremely stable electrical and mechanical characteristics. These diodes are specially designed and constructed to meet the most exacting requirements of military or commercial applications. They are double wire ended and fusion-sealed in a subminiature one-piece glass envelope to ensure complete isolation of the active elements from damage or contamination. The small size, combined with rigidity of construction and small mass of the elements, enable them to withstand successfully physical shock and vibration.

Type No.	Continuous Ratings 25°C		Characteristics 25°C	
	Max. Rated P.I.V. (Volts)	Max. Forward Current	Min. Forward Current at 1.5V	Max. Reverse Current at P.I.V.
HS1101	150	80 mA	30 mA	1 μA
HS1102	100	80 mA	30 mA	1 μA
HS1103	50	80 mA	30 mA	1 μA
HS1104	150	60 mA	15 mA	1 μA
HS1105	100	60 mA	15 mA	1 μA
HS1106	50	60 mA	15 mA	1 μA
HS1107	150	40 mA	5 mA	1 μA
HS1108	100	40 mA	5 mA	1 μA
HS1109	50	40 mA	5 mA	1 μA

TEMPERATURE RANGE -65°C TO 150°C

Typical Stored Charge Measurement, 700 pico—coulombs.
Typical recovery time:
0.8 μsec measured in JAN555 circuit, to 80 K ohms when switched from I_F 5 mA to V_r—35 volts
1.0 μsec measured in IBM "Y" circuit to 400 K ohms when switched from I_F 20 mA to V_r—35 volts
Special Diodes from this range are available, featuring higher conductivity or faster recovery.

Qualified engineers in our Research and Development laboratories at Glenrothes are available to help with your application problems.

Home and Overseas enquiries to:

HUGHES INTERNATIONAL (U.K.) LTD

KERSHAW HOUSE, GREAT WEST ROAD, HOUNSLOW, MIDDLESEX · HOUNSLOW 5222

EE 33 156 *for further details*

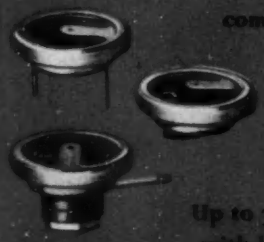
BIGGEST CAPACITANCE *smallest size:* WIDEST TEMPERATURE RANGE IN ELECTROLYTIC CAPACITORS

Plessey tantalum capacitors, originally developed to meet stringent aircraft and guided missile requirements, are finding many new applications in electronic equipment. For operation from sub-zero to tropical temperatures, wherever small size, low leakage and long life are demanded, Plessey tantalum capacitors have the highest capacitance/volume ratio of any capacitor available to-day.

CASTANET PELLET CAPACITORS

Outstanding features include low leakage current, temperature range −55°C to + 125°C, and a shelf life of 10 years. Principal uses are in smoothing, coupling and bypass applications.

TYPE A. The standard unit, type approved and complying with RCS 134B, is ¼ in. diameter and ¼ in. deep, with a working voltage of 30V d.c. at the basic capacitance of 50 μF. Up to 750 μF can be achieved with lower working voltage.

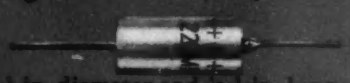


TYPE E. A miniature tubular unit, ¼ in. diameter and ½ in. long, in which the capacitance range 4 to 200 μF corresponds to d.c. working voltages of 30 to 3V.

TYPE J. The smallest 'Castanet' capacitor—only $\frac{1}{16}$ in. in diameter and $\frac{7}{16}$ in. long. Values range from 1 μF at 30V d.c. to 20 μF at 3V d.c.

SOLID ELECTROLYTE CAPACITORS

Particularly advantageous in miniature transistorised equipment, these capacitors have d.c. working voltages in the range 6V to 35V, and capacitances from 4,700 μF to 330 μF. Temperature range is −80°C to + 125°C, and the smallest capacitor measures only ¼ in. diameter and is ½ in. long.



Write for full details of the Plessey range of tantalum capacitors.

'Castanet' is a registered Trade Mark

Plessey

TANTALUM ELECTROLYTIC CAPACITORS

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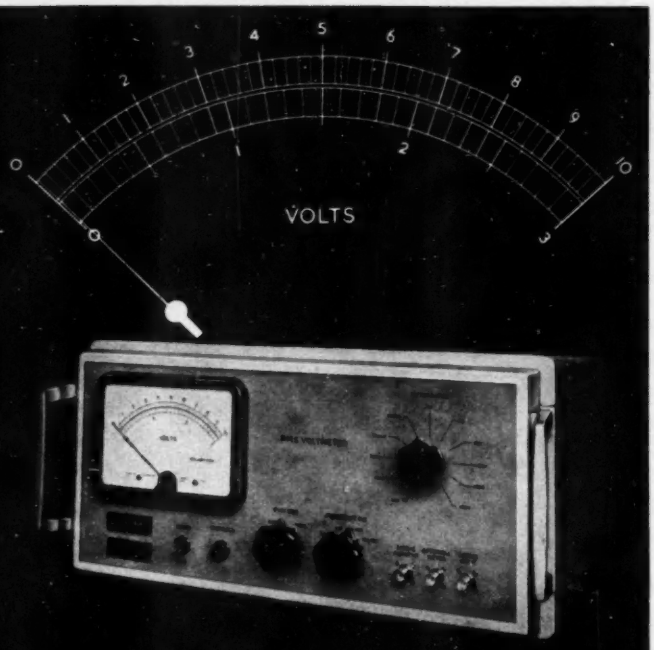
SOLARTRON

A. C. Millivoltmeters



PRECISION R.M.S. MILLIVOLTMETER JM 1067

TRUE R.M.S. READING OF COMPLEX VOLTAGE WAVEFORMS —ON A 5″ LINEAR SCALE

- **3 mV to 300 V f.s.d. Range**
- **Accuracy ± 2%**
- **0.1 c/s Low Frequency Limit**
- **Neon Overload Indicator to ensure accurate readings**
- **Silicon Diodes throughout**

PRECISION R.M.S. MILLIVOLTMETER JM 1067 measures the true r.m.s. value of non-sinusoidal waveforms as well as normal sinusoidal inputs. It uses D.C. operational amplifiers and diode function generators to perform the 'squaring' and 'square-rooting' operations for true r.m.s. readings.

SPECIFICATION

Voltage range:	0–3 mV to 0–300 V r.m.s. in eleven ranges.
Accuracy:	± 2% of f.s.d.
Frequency range:	0.1 c/s—10 kc/s.
Input Impedance:	1M Ω.
Outputs:	Amplified Signal of ± 50 V max. ; Available on the R.M.S. output of 0 to −50 V d.c. ; front panel.
R.M.S./Mean Switch:	Allows measurement of r.m.s. or rectified mean values.
Smoothing:	4 smoothing time constants to suit input frequencies.

PRECISION A.C. MILLIVOLTMETER VF 252

FOR AUDIO AND CARRIER SINEWAVE APPLICATIONS

- **1.5 mV to 150 V f.s.d. range**
- **Accuracy ± 1% f.s.d.**
- **10 c/s—100 kc/s frequency range**
- **dB scales for response measurements**
- **Input Z of 30 M Ω or 1 :1 isolating transformer**

Clear and accurate readings of small signal inputs given on a 6″ scale, covering a frequency range 10 c/s—100 kc/s. The wide dB range −80 dB to +34 dB (referred to 1 volt) makes the VF 252 an ideal instrument for accurate frequency response measurements on amplifiers and filter networks.

SPECIFICATION

Voltage range:	0–1.5 mV to 0–150 V f.s.d. in 9 ranges and 10:1 attenuator.
dB scales:	−10 to +14 dB and −20 to +4 dB.
Frequency range:	10 c/s—100 kc/s.
Accuracy:	± 1% f.s.d. at 1 kc/s.
Input Z:	30 M Ω shunted by 30 pF.
Alternative Inputs	
Input Attenuator (1M Ω):	10:1 ratio.
Isolating Transformer:	1:1 ratio (Primary Inductance 50H).

Write now for full details to:

SOLARTRON LABORATORY INSTRUMENTS LIMITED

Cox Lane, Chessington, Surrey

Tel: LOWer Hook 2150 · Cables: SOLARTRON CHESSINGTON

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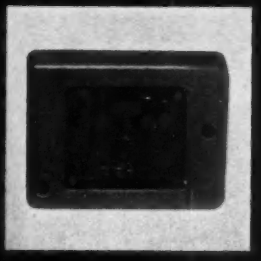
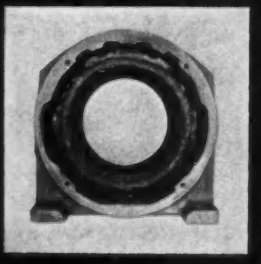
EE 33 158 *for further details*

new 'Silcoset' rubbers from I.C.I.





I.C.I. announces the addition of two new 'Silcoset' rubbers to its range of room-temperature-curing silicone rubbers.

'Silcoset' 103 is a white solvent-free paste suitable for use where absence of colour is important—in applications concerned with foodstuffs, for example.

'Silcoset' 104 is a thixotropic solvent-free paste of particular value in caulking and sealing applications.

Both 'SILCOSET' 103 and 'SILCOSET' 104 cure at room temperature to resilient silicone rubbers, after a curing agent has been added.

I.C.I. offers four curing agents: A—standard; B—slow; C—non-toxic; D—fast.

'Silcoset' rubbers are being used for potting and encapsulating electronic parts, 'in situ' coating of conveyor belting, replacement parts in surgery, flexible moulds for resin casting, e.g., model-making.

'Silcoset' rubbers may be just what you've been waiting for. Find out more about them—write to your nearest I.C.I. Sales Office or to:

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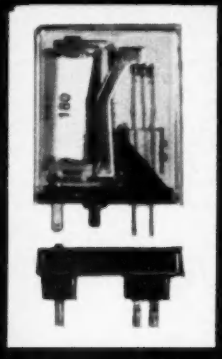
NS. 90

Varley

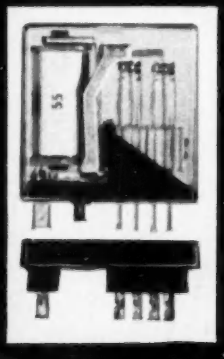
miniature plug-in relays

British made . . . for long life and perfect contact

VP 2



VP 4



- Type V.P.2. 0.75″ × 0.96″ Panel height 1.175″ (with socket 1.35″)
- Type V.P.4. 0.75″ × 1.18″ Panel height 1.175″ (with socket 1.35″)
- 2 or 4 pole changeover (other contact arrangements being developed)
- Operating voltages: 6-138v D.C.
- Operating times: 3½ to 7½ milliseconds
- Operating life: in excess of 10^7 operations.
- Contact ratings: 1 amp at 100v. Maximum watts: 30.
- Contact material: fine silver and gold alloy. Other contact materials will be available later.
- Plug-in and fitted with dust cover (Printed circuit socket later).

Delivery ex stock

For further information write Dept. E.I

OLIVER PELL CONTROL LTD.

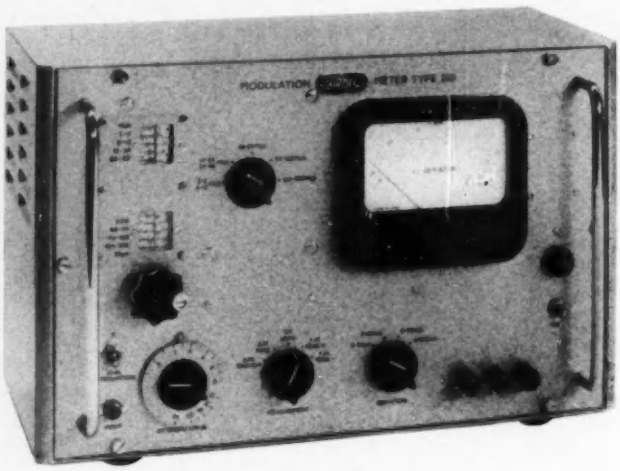
Cambridge Row, Bunhill Row, Woolwich, S.E.18

Telephone: Woolwich 1428 (7 lines)

Telegrams: Oliver, London, S.E.18

Varley

EE 33 160 *for further details*



Your modulation meter-

Has it a wide frequency range?
The 210 has a range of 2.25 to 300 Mc/s, which may be extended to 600 Mc/s with reduced sensitivity.

Will it accept both A.M. and F.M. signals?
The 210 provides direct measurement of both types of modulation. On the A.M. range it measures 0 to 100% peak and trough modulation relative to the mean carrier level; on the F.M. range it measures positive or negative peak frequency deviation from the mean carrier frequency in four ranges—0-3 Kc/s, 0-10 Kc/s, 0-30 Kc/s, and 0-100 Kc/s.

Does it cater for low signal input levels?
The 210 will measure the following inputs
A M — 7 mV to 700 mV
F M — 7 mV to 10 V (3-100 Kc/s)
50 mV to 10 V (0-3 Kc/s)

Can you see what is happening?
The 210 provides monitor outputs of both L F and I F at terminals on the front panel. The I F output is at 750 Kc/s and allows the modulation envelope of the input signal to be observed on an oscilloscope.

Is it easy to operate?
With the 210 you tune, set meter level, select the quantity to be measured and read off the answer directly on the meter.

In instrumentation

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PARMEKO ATLANTIC SERIES

STANDARD TRANSISTOR SUPPLY TRANSFORMERS

This range has been developed primarily for providing a power supply to transistorised circuits, but can also be used for many other applications where a low voltage output is required.

SECONDARY (a): Windings of 1 to 24V. are tapped in approximately 1 volt steps and those of 2 to 48V. in approximately 2 volt steps. The D.C. current ratings shown are those obtainable from a bridge rectifier with either choke or condenser filter.

SECONDARY (b): An H.T. winding is provided on certain models for stabilised circuits and this is tapped at each 50V. from 0-250 volts.

All Standard transformers have their primaries wound 10-0-200-220-240V. 50 c.p.s. supply. An electrostatic shield is fitted between primary and secondary windings on all models.

CATALOGUE No.	SECONDARY (A)			SECONDARY (B)	
	VOLTAGE R.M.S.	RATING (AMPS)		VOLTAGE R.M.S.	RATING
		R.M.S. OR D.C. CHOKE	D.C. COND.		R.M.S. CURRENT
P-2945	1 to 24V.	1·6A.	1·0A.	—	—
P-2946	2 to 48V.	1·6A.	1·0A.	—	—
P-2947	1 to 24V.	3·2A.	2·0A.	—	—
P-2948	1 to 24V.	1·6A.	1·0A.	0–250V. (50V. Steps)	40mA
P-2949	2 to 48V.	1·6A.	1·0A.	0–250V. (50V. Steps)	40mA
P-2950	1 to 24V.	3·2A.	2·0A.	0–250V. (50V. Steps)	40mA
P-2951	2 to 48V.	3·2A.	2·0A.	0–250V. (50V. Steps)	40mA
P-2952	1 to 24V.	5·0A.	3·2A.	0–250V. (50V. Steps)	40mA
P-2953	2 to 48V.	5·0A.	3·2A.	0–250V. (50V. Steps)	40mA

A table showing method of connection is supplied with each transformer.

- ★ *DESIGN: Complies with BSS 2214.*
- ★ *CONSTRUCTION: Steel encased, compound filled.*
- ★ *DIMENSIONS: Plan and Fixing to R.C.L.215.*
- ★ *HUMIDITY: Category H2 or Better.*
- ★ *TERMINALS: Pressed dodge insulators, layout to R.C.L.215.*
- ★ *MOUNTING: Upright or Inverted.*
- ★ *FINISH: Grey Hammer, enamel enamel.*
- ★ *STANDARDS: Range of Transformers and Chokes available from stock.*

STANDARD SMOOTHING CHOKES

Catalogue Number	D.C. Current	Inductance	Approx. D.C. Resis. Ohms.	Model Size	Terminal Positions
P-2954	1·6A	40mH	0·62	9000/49	2–3
P-2955	1·6A	60mH	0·90	9000/57	9–10
P-2956	3·2A	15mH	0·31	9000/49	2–3
P-2957	3·2A	35mH	0·39	9000/65	9–10
P-2958	5·0A	9mH	0·15	9000/57	9–10
P-2959	5·0A	25mH	0·16	9000/73	9–10

The Atlantic Series can accommodate transformer designs rated up to 650VA at 50 c.p.s. We shall be pleased to quote for your specific requirements.

PARMEKO LTD · PERCY ROAD · LEICESTER · ENGLAND

C 13

EE 33 162 *for further details*

★ MULTI-CIRCUIT ★

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P.4 Rotary Packet Switch arranged for panel and base mounting with machine type handle

Quick make and break action

Simple design · Robust construction

Minimum panel space required

High rupturing capacity

Available in a wide range of ampere ratings

Multi-switching cuts cost

P.4 SERIES

Maximum Non-Reactive Ratings

30/35 Amps 250v AC/DC 20/30 Amps 440v AC/DC

15/25 Amps 600v AC/DC

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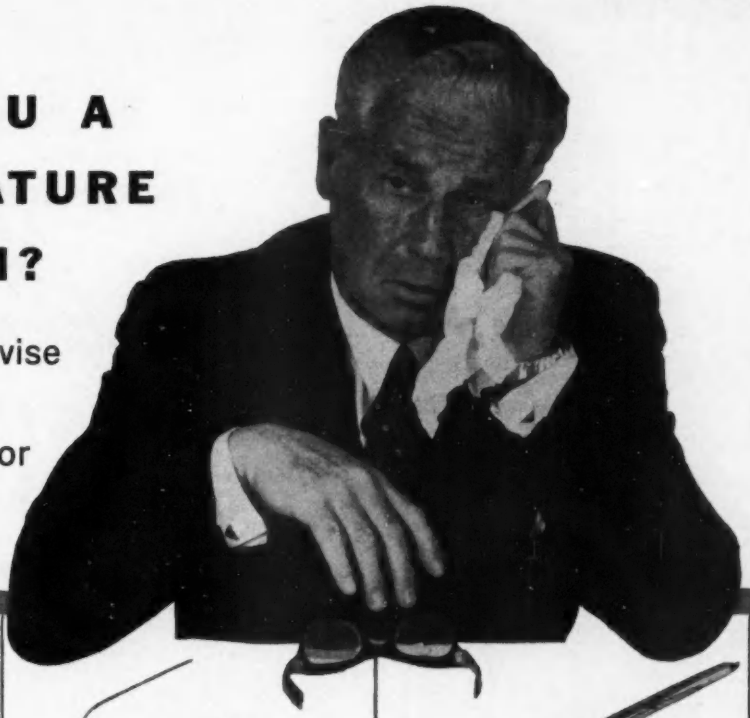
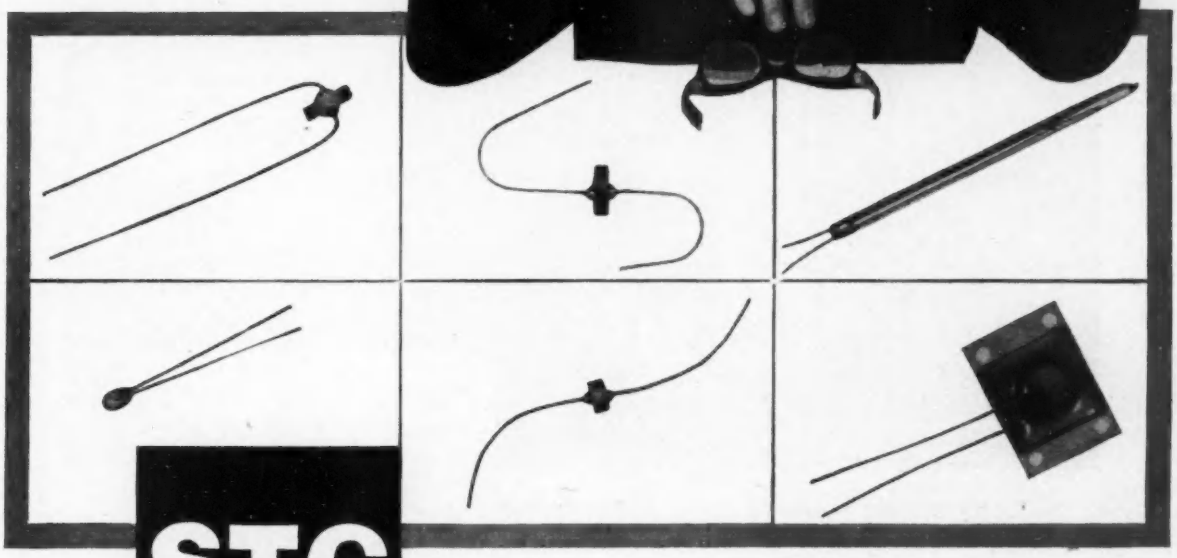
A/31 (REV)

HAVE YOU A TEMPERATURE PROBLEM?

Then let **STC** advise on the use of a suitable thermistor





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THERMISTORS ARE

FAST
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ROBUST

The use of STC thermistors as electrical thermometers includes a range of applications as diverse as the measurement of soil, water and air temperatures, the measurement of bearing temperatures in large machines and certain medical measurements where, for example, thermistors are specially constructed for insertion into hypodermic needles.

At your disposal, and backed by 20 years' experience of thermistor manufacture, is a wide range of types suitable for temperature measurement, control and compensation.

Consult leaflet MK/140 which contains summary information on all types in the standard range, or contact the Transistor Division for guidance on your particular problem and for details of non-standard types.

STC COMPONENTS GROUP

61/9MK

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TRANSISTOR DIVISION: FOOTSCRAY · SIDCUP · KENT

For general laboratory use

G.E.C.

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MARCONI TEST EQUIPMENT

VIDEO OSCILLATOR TF 885A/1
being used, in conjunction with Oscilloscope TF 1330 and Vacuum Tube Voltmeter TF 1041B, to investigate the L.F. response of a T.V. set video amplifier stage in the laboratories of the G.E.C.'s Radio & T.V. Works, Coventry.

The Marconi Video Oscillator TF 885A/1 is one of many types of Marconi instruments employed by the renowned General Electric Company at their Coventry laboratories. The Video Oscillator is a wide-range (25 c/s to 12 Mc/s) standard test signal source for general laboratory use. Its calibrated attenuator facilitates accurate gain or loss measurements on active or passive networks, and the purity of the output waveform permits the instrument to be used for such measurements as amplifier linearity and intermodulation. Full details of this versatile oscillator, and information about other Marconi instruments that interest you, will gladly be sent on request. Please ask for Leaflet J 187.

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REPRESENTATION IN 68 COUNTRIES

TC187

HIGH TEMPERATURE FOIL TYPE

(POLAR AND NON-POLAR)

Designed to withstand conditions of high temperature and high vibration.
Temperature Range: −40 to +125°C.
Voltage Range: 6 to 100V. d.c.
Capacitance Range: 0.2 to 200 μF.

STANTELUM

TANTALUM

ELECTROLYTIC CAPACITORS

STANDARD FOIL TYPE

(POLAR AND NON-POLAR)

Type approved to R.C.S.134B
Temperature Range: −40 to +85°C.
Voltage Range: 6 to 150V. d.c.
Capacitance Range: 0.15 to 200 μF.

SOLID TYPE

(POLAR)

Sintered Slug and solid electrolyte construction.
Temperature Range: −55 to +85°C.
Voltage Range: 6 to 35V. d.c.
Capacitance Range: 1 to 220 μF.

MINIATURE FOIL TYPE

(POLAR)

A foil type tantalum capacitor in its most economical form.
Temperature Range: −25 to +70°C.
Voltage Range: 3 to 25V. d.c.
Capacitance Range: 1.5 to 16 μF.

STC manufacture a full range of tantalum electrolytic capacitors.

Write for Data Sheets to:

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61/5MC

Standard Telephones and Cables Limited

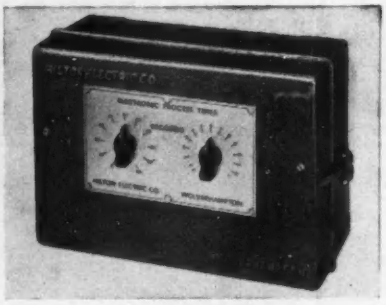
Registered Office: Connaught House, Aldwych, London W.C.2

CAPACITOR DIVISION: BRIXHAM ROAD · PAIGNTON · DEVON

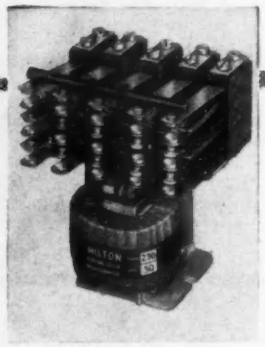
EE 33 166 *for further details*

PRODUCTION

DELAY RELAYS
Efficient, Compact, Economical



TIMERS
Electronic Process Timers for Automation



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MINIATURE STABILISED

POWER UNIT

TECHNICAL SPECIFICATION

Mains Input	*: 200-250v AC*
Outputs	*: Two 4-pin sockets*
Output DC Current	*: 0-100 mA shared between sockets*
Output DC Voltages	*: 150v 200v 250*
Regulation	*: 0·15% 0·025% 0·025%*
Voltage stabilization Ratio	*: 0·1/5 0·075/5 0·075/5*
Ripple	*: Less than 0·4mv RMS on full load*
AC Output	*: 6·3V, 2A at each socket*
Size	*: 5¼" × 5¼" × 5¼"*
Weight	*: Approximately 9½ lbs*
Delivery	*: Early delivery can be given*

PAMPHLET No. 1241b ON REQUEST

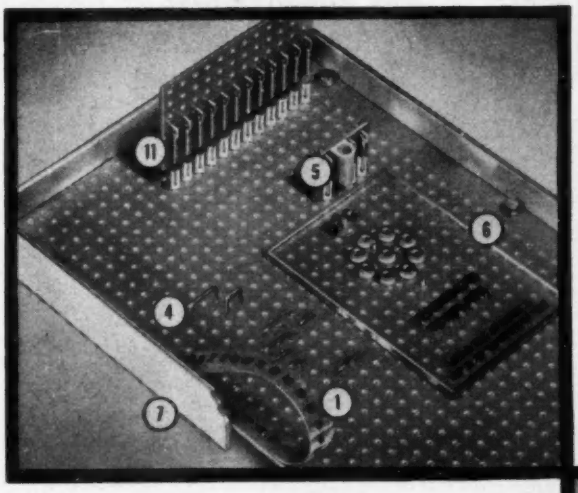
Other voltages within the range 150-250v can be supplied to order.
By means of simple links, one unit can provide any one of three output voltages.

BARR & STROUD LTD. ANNIESLAND, GLASGOW, W.3
London Office: Kinnaird House, 1 Pall Mall East, S.W.1

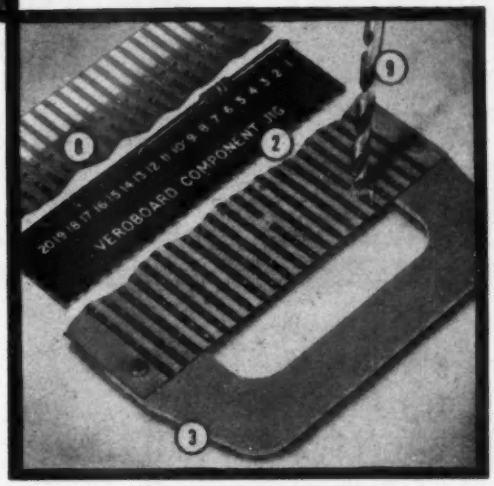
EE 33 167 *for further details*

EE 33 168 *for further details*

Fast, simple, low-cost circuit assembly



with **vero board accessories**



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3 **Plastic Handles** for plug-in VEROBOARD card circuits. Part Nos. VB3051 (black) and VB3052 (red)

4 **Jumper Links** of tinned copper wire for cross connections between bonded copper backing strips on VEROBOARD. Part Nos. VB3061 (0·2″) and VB3062 (0·4″)

5 **Semiconductor Holders** for mounting transistors, etc. with plug-in contacts on 0·2″ matrix. Part No. VB2011 and VB2012

6 **Valveholder Templates** for drilling holes at correct pitch and location on VEROBOARD. Part Nos. VB3041, VB3042 and VB3043

7 **Extruded Edging** in light alloy for strengthening VEROBOARD panels. Part No. VB3091

8 **Plug-in Panels**: 4·8″ × 5·8″ VEROBOARD, gold-plated at one end for use with edge connectors. Part No. VB2001

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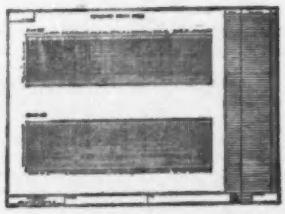
10 **Design Sheets** on high quality tracing paper for designing circuits on VEROBOARD and for producing workshop prints. Part Nos. VB3071 (18″) and VB3072 (6″)

11 **Varicon Connectors** which can be used as single point contacts or in rows to form connections between VEROBOARDS. Available in strips of 20. Part No. VB3081 (in line and VB3082 (right angle).



Notching Tool for Extruded Edging to enable it to be mitred for making corners and for slotting to take VEROBOARD panels. Part Nos. VB3101 Press, VB3102 Mitre die set, VB3103 Slotting die set.

VEROBOARD Kit contains supply of VEROBOARD and accessories.

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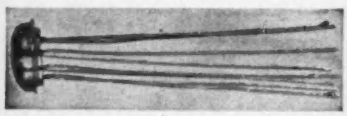

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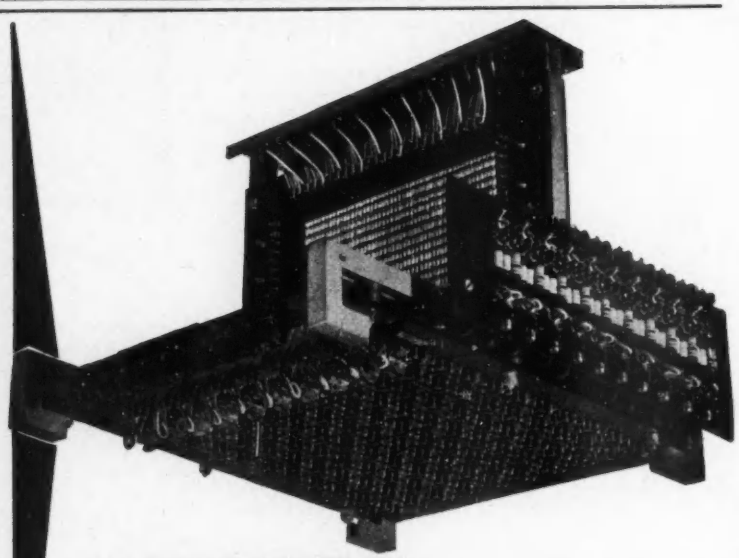

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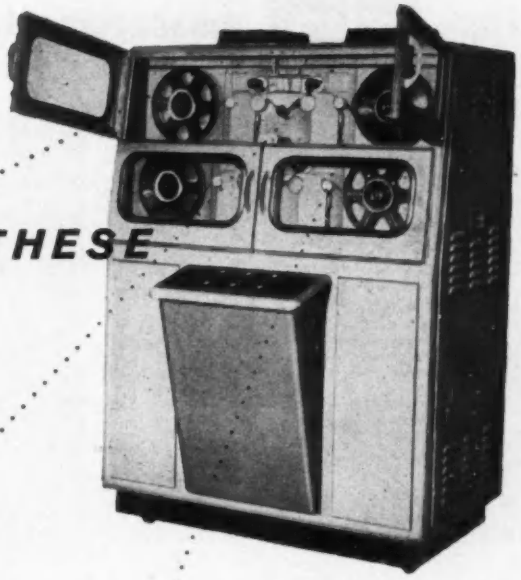

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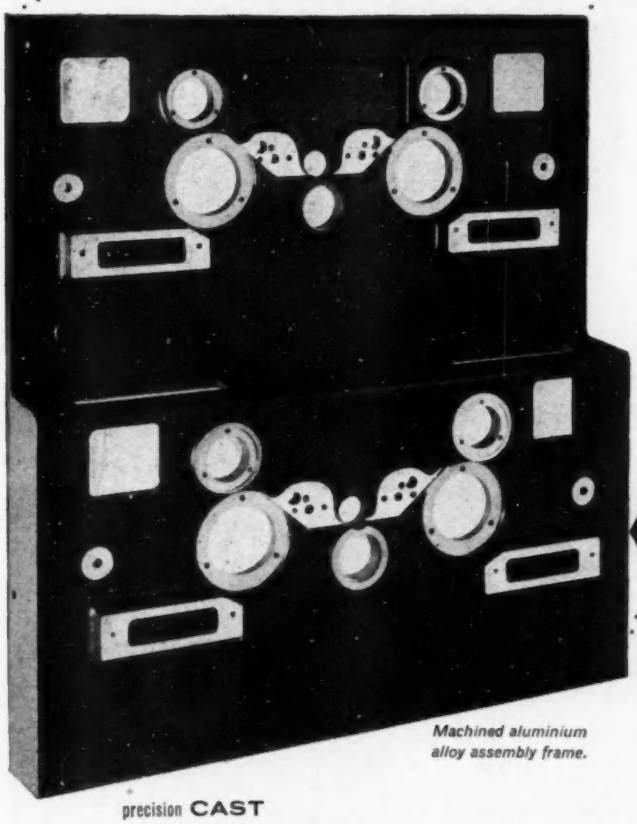

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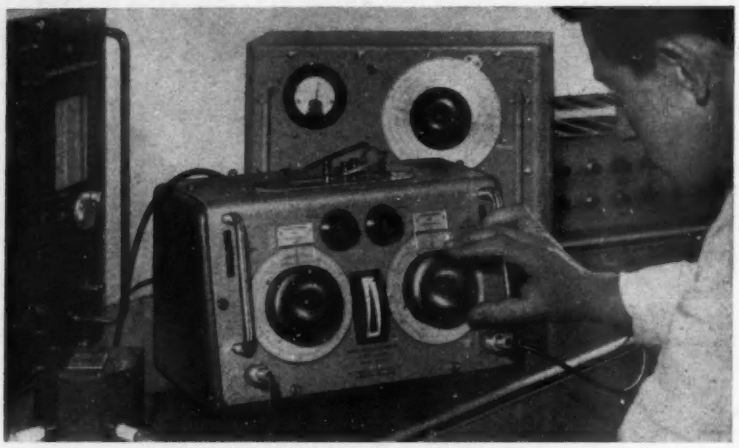

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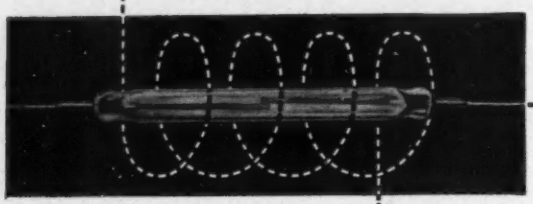

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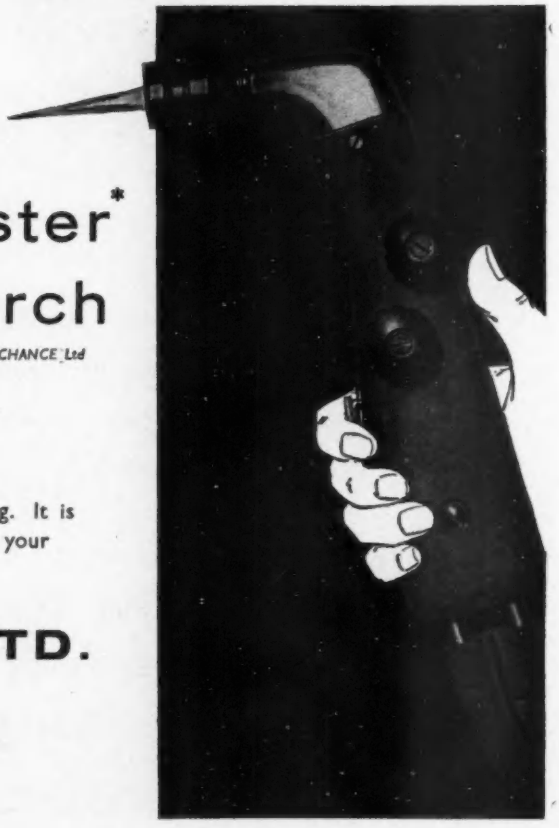

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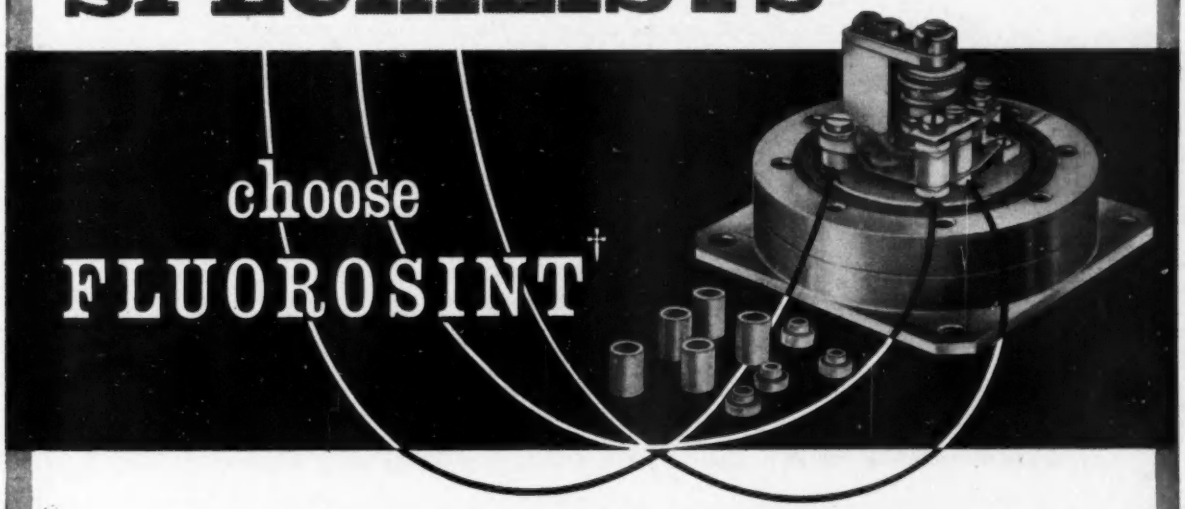

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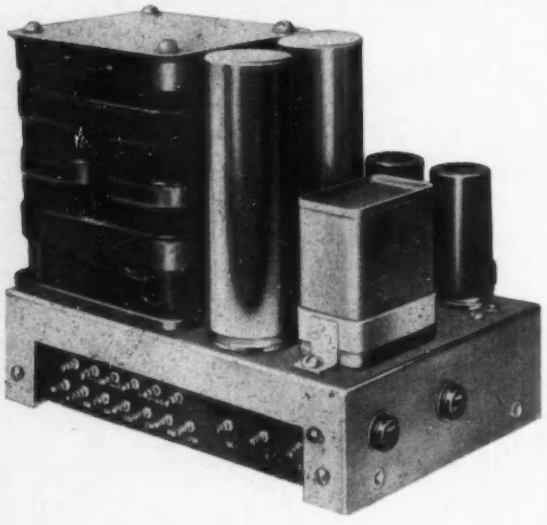

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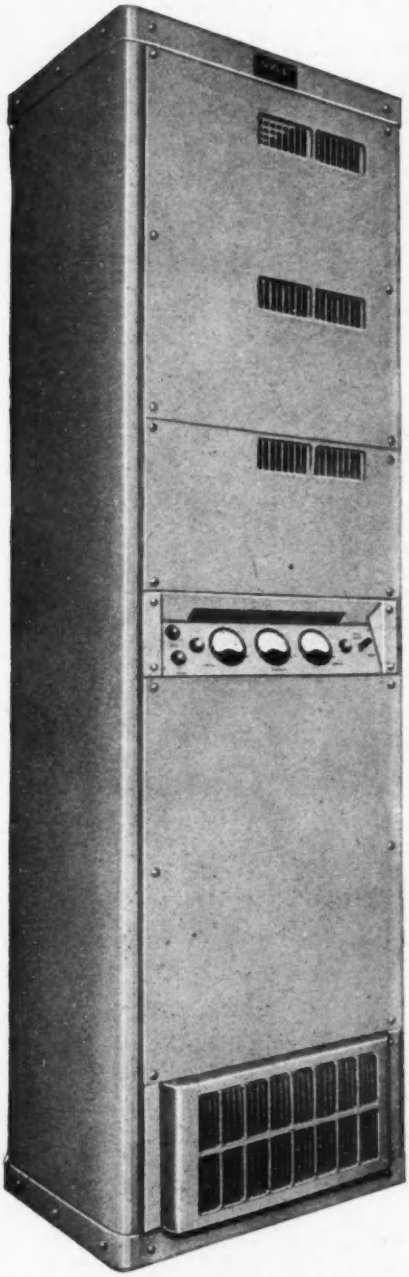

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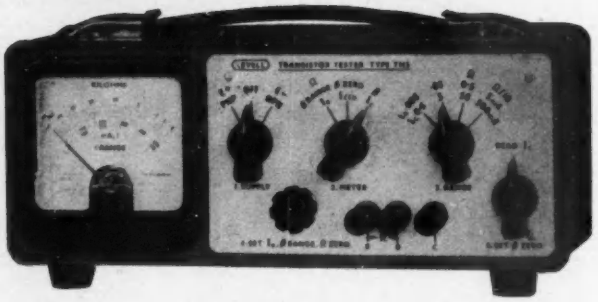

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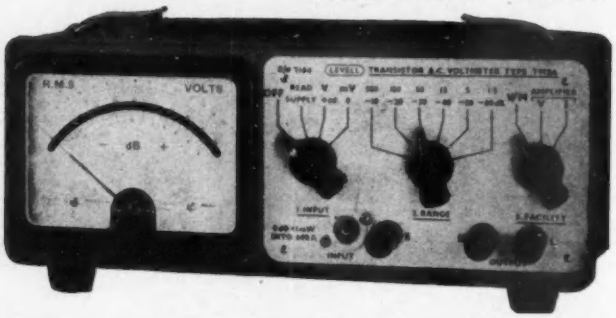

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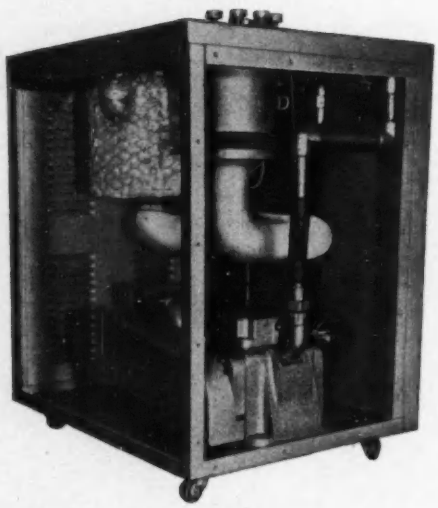

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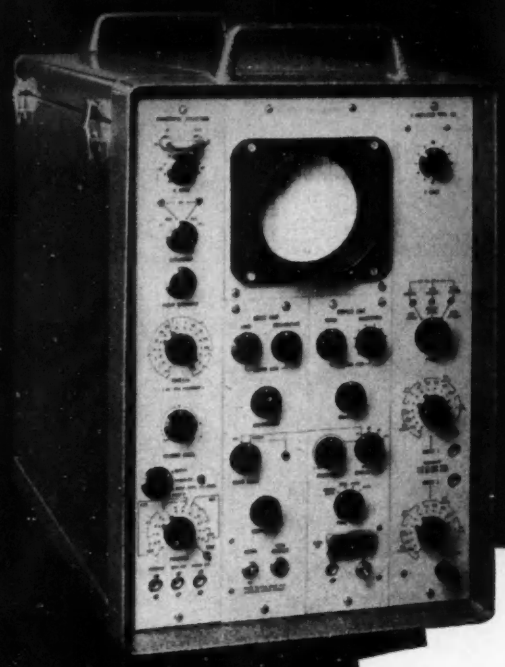

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FULLY AUTOMATIC WINDING MACHINES
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WINDING UNITS · TAKE-OFFS · MULTI WINDERS

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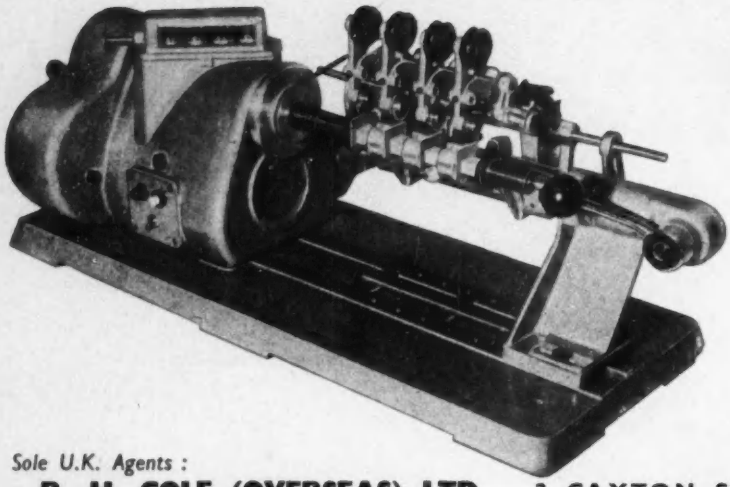
DRUMPACK WINDERS · **TAKE-UP & WINDING UNITS**
with traverse gears — with automatic tension and speed control



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for all purposes

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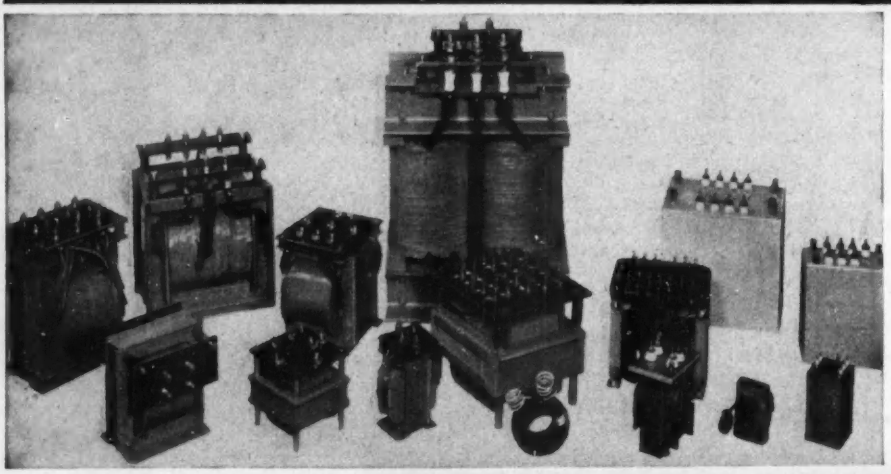

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...Fastest service

Virtually every type and value of resistor available can be supplied immediately—ex-stock—by The Radio Resistor Co. Ltd. High stability, solid carbon, cracked carbon, wirewound, precision metal oxide, epoxy resin resistors. Miniature and sub-miniature potentiometers. All are described in the illustrated stock book and price list issued free every alternate month on application.

CARBON	WATTS	OHMIC RANGE	TOLERANCES ±
1. Solid	1/10—1/2 1 and 2	10—10M	5% 10% 20%
2. Cracked	1/30—1	1Ω—10M	5% and 10%
5. V. High Resistance	1/4—3	50M—10^{13}	5%—25%
6. *High Stability	1/10—2	1—50M	0·5% 1% 2% 5%
7. High Stability encapsulated in Epoxy Resin	1/4, 1/2, 1	10Ω—4·7M	1% 2% 5%
4. Metal Oxide Precision	1/4—2	100—4·2M	1% 2% 5%
WIREWOUND			
8. Vitreous	1—500	1—150K	1% 2% 5%
3. Cemented	1/2—15	1—25K	5% and 10%

**The ubiquitous blue (1%) grey (2%) "HISTABS"*

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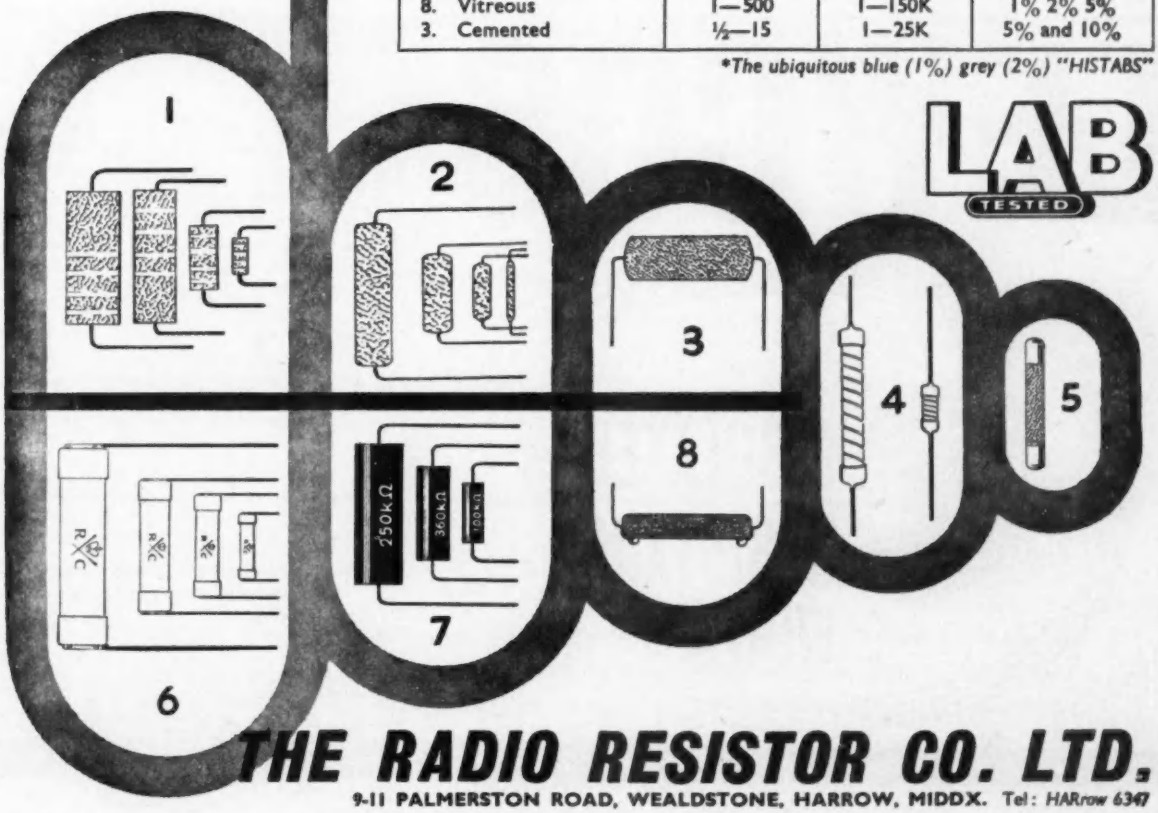

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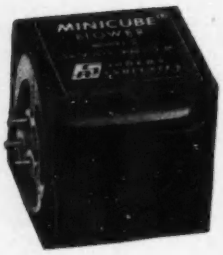
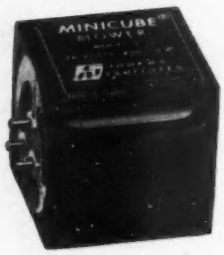
SUBMINIATURE 400 c/s BLOWER





Unique construction within a 1″ cube.

Power consumption only 3 watts.

Quiet operation.

Weight only 1¼ oz.

Operation temperature range —55°C +110°C (ambient).

STAND No. 353
R.E.C.M.F. EXHIBITION
OLYMPIA 30th MAY—2nd JUNE

This blower offers outstanding advantages to equipment designers and its small size enables it to be mounted adjacent to the component to be cooled in the majority of cases, thus using the air output to the maximum effect and affording an extra saving in weight and power consumption.

Send for full information on the "AIRMAX" range.

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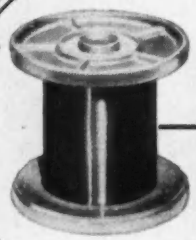

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For resistors in instruments, radio, television, electronic and control apparatus and many other applications.
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This is news!

now...a *transistorized* chopper

Price in the U.K. for small quantities, available from stock, £8.5.0d.
Unsealed versions of the SM.10 transistorized chopper are in use in the control systems of British Nuclear Power Stations and have already given three years trouble-free service — Thus proving their stability and reliability.

New from TMC comes the ELECTRONIC MODULATOR SM. 10 — the first fully encapsulated transistorized chopper to be produced and sold in quantity in Gt. Britain. The SM. 10 is a highly stable, clamp-type chopper with silicon transistors, designed for low level d.c. chopping. Unlike electro-mechanical choppers, the S.M. 10 has no moving parts to wear, or contacts to become contaminated. What is more, it will never need adjustment!

The SM. 10 has all these advantages:

- Noise level so low that it will switch a voltage of one microvolt.
- Extremely high stability over the temperature range 0° to + 55°C.
- Carefully matched, selected components give low drift and almost limitless life.
- Will operate from any 6 volt sinusoidal or square-wave supply—at frequencies from 40 c/s to 1000 c/s.
- Small and compact—fits B9A socket and measures only 1⅛" × 1¼" diameter.
- Epoxy resin cast and aluminium encapsulated — will withstand excessive vibration and shock effects (suitable for all military and commercial projects).

See these and other TMC components on Stand 304 at the Radio and Electronic Components Exhibition.

The SM. 10 is designed and manufactured by Bailey Meters and Controls Limited, and marketed by:—

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A SPECIAL LOW VOLTAGE TESTER L.V./F.P. IS ALSO AVAILABLE FOR 24/100 VOLTAGES

57/9

Don't take chances—play safe with the approved voltage Tester, the MARTINDALE Model F.P. incorporates exclusive features and advantages (including unique prod design) that make for maximum efficiency with complete safety. Instantly records voltage (up to 600), whether A.C. or D.C., if wires dead or alive, which is "earth". Fully fused and protected. You cannot afford to pay less than the modest price asked for the MARTINDALE Voltage Tester—*and you cannot buy better, no matter how much more you pay.*

For full details write to :

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HIGH TENSILE BARS up to 4½" diameter.

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WIRE in all sizes from 0.0076" diameter upwards.

STRAND. **SHEETS** up to 6ft. x 3ft. x $\frac{3}{16}$in. diameter upwards. **STRIP AND FOIL**

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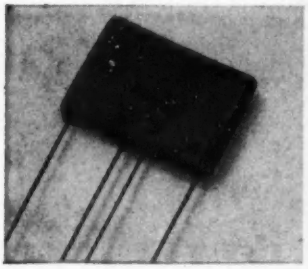
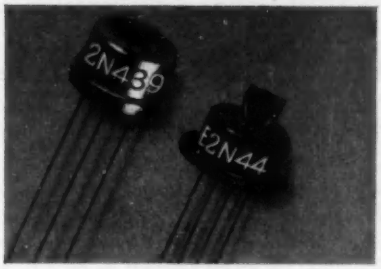
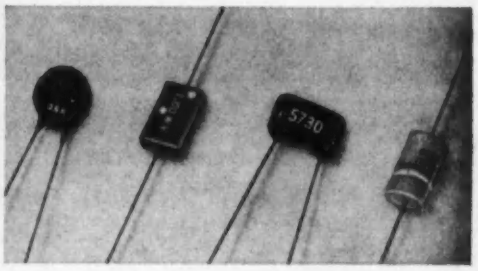
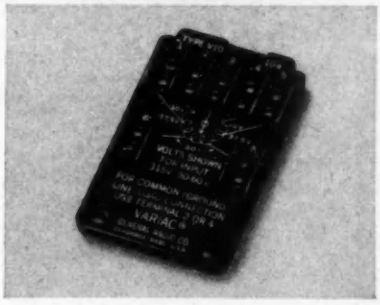
FROM *MARKEM*- EVERYTHING YOU NEED TO MARK ALL OF YOUR PRODUCTS AND PACKAGES

Markem machines are used throughout the world to mark electrical and electronic components of every description —*at production speeds*— with clear, durable imprints. Machines ranging from the small, hand-operated "Companion" to completely automatic high speed types are capable of handling products and packages of almost any size and shape. Printing elements are available for marking almost any surface — for production runs or for short runs with frequent imprint changes. And the wide choice of Markem specialty inks offers various drying characteristics and resistance to almost any environmental condition. Machines, printing elements, inks, supplies, plus competent advice and service — all are available from Markem, the complete source, with 49 years of experience in industrial marking.









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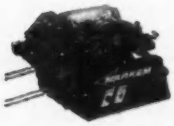
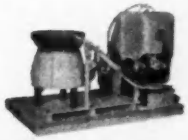
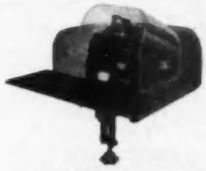


Model 146A — Marking Axial Lead Components with complete legends, including polarity band. Prints neatly on curved, uneven or irregular surfaces. Can be adjusted quickly to different sizes of components. Production speed up to 3000 per hour.



Model 122A — Simultaneous Top and Side Marking as well as date coding of transistors, similar cylindrical components with base leads. Hopper-fed machine automatically prints and ejects up to 3000 per hour.



Model 148A — Completely Automatic Marking of all types of surfaces — flat, curved, corrugated, irregular, etc. — without hand rolling or pressing. May be mounted for automatic in-line marking or objects may be hand fed to adjustable work table. Average production 2100 to 3100 per hour.

Model 69A — Color Banding of diodes, resistors, capacitors, similar axial lead cylindrical components up to 4800 per hour. Up to 6 colors simultaneously, or 5 color bands plus typographical marking. Color, band width, spacing easily changed.

Write for this 12-page catalog of Markem machines and related equipment for the electrical and electronics industries. Complete specification sheets are also available for individual machines.

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The careful electrician uses

The **MARTINDALE**

VOLTAGE TESTER

A SPECIAL LOW VOLTAGE TESTER L.V./F.P. IS ALSO AVAILABLE FOR 24/100 VOLTAGES

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HIGH TENSILE BARS up to 4½" diameter.

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WIRE in all sizes from 0.0076" diameter upwards.

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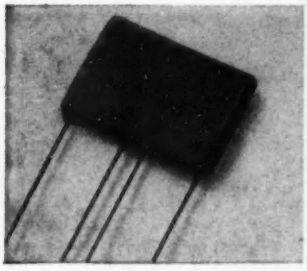

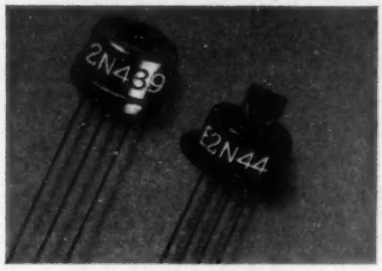

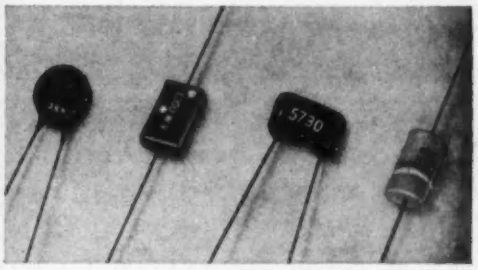

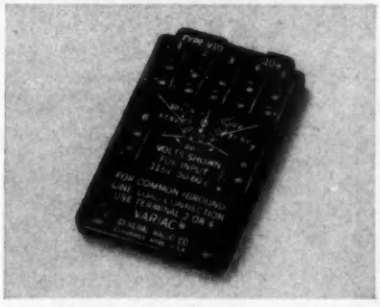

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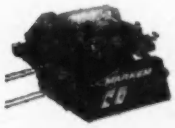

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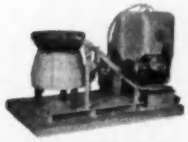

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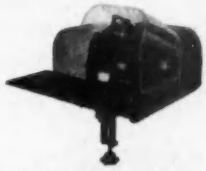

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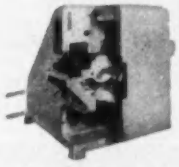

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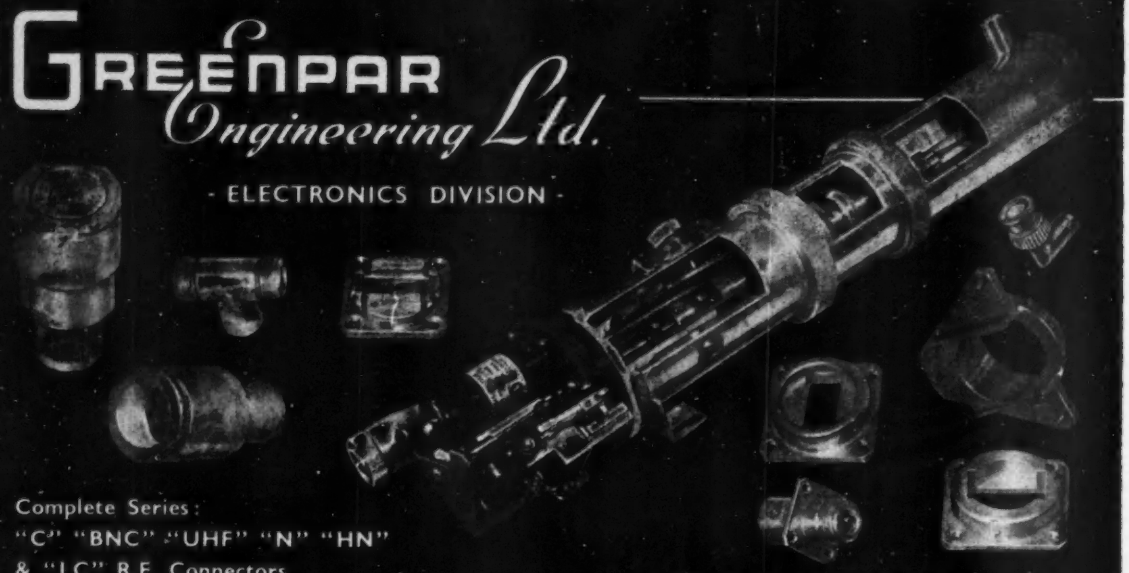
GREENPAR *Engineering Ltd.*

- ELECTRONICS DIVISION -



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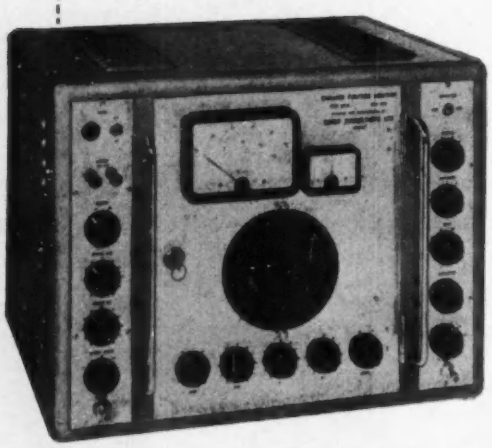

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This versatile instrument features within a single cabinet:

Direct indication of phase angle
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Test frequency range: 0·03-250c/s
Decade setting of test frequency
Modulated carrier or DC output
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Mechanical output
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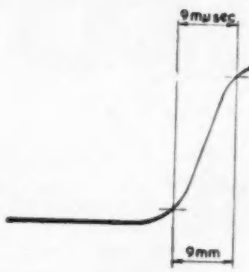
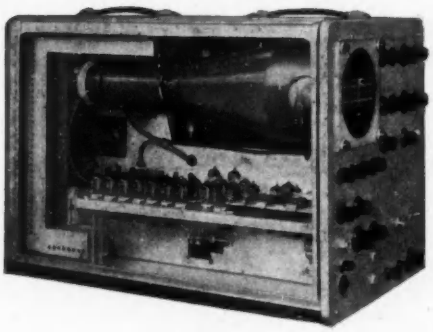


The Sign of a good High Speed C.R.O



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THE NAGARD MODEL 301

Designed around the latest type of high sensitivity cathode ray tube. this instrument provides all the essential features of a wide band oscilloscope with accurate measuring facilities and an exceptionally wide range of sweep speeds. The aim has been to get these features incorporated in the least complicated manner, and produced to the highest standard of workmanship at an economical price.

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Trigger Setting in six modes with level, stability and polarity controls.
Vertical deflection over a bandwidth of DC to 40 Mc/s (−3bB).

Rise time: 9 mμsec.

Sensitivity: 1 cm/100 mV to 1 cm/20 V continuously variable, extended to 1 cm/200 v by probe. Calibrated and stable gain settings.

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Pre-amplifier: Can be switched in and then provides:—
Maximum Sensitivity of 10 mV/cm over bandwidth of 2.5 c/s to 20 Mc/s.

C.R.T. Has 10 KV accelerating voltage and high efficiency screen giving exceptionally good resolution and high writing speed.
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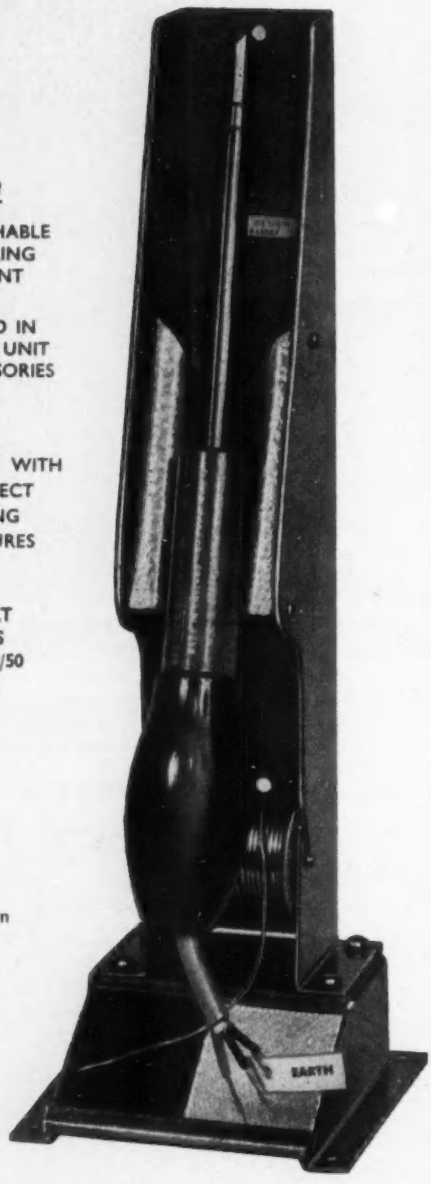

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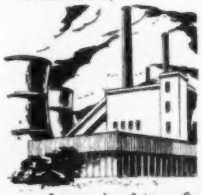

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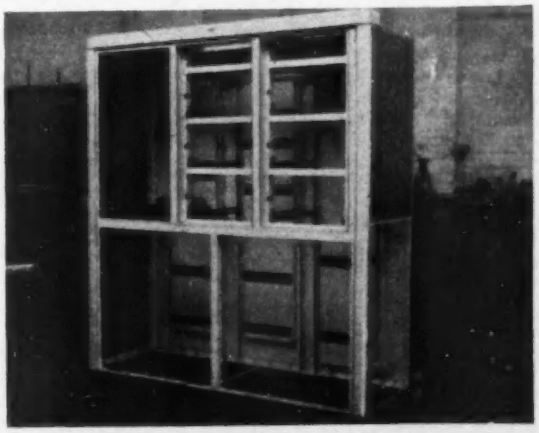

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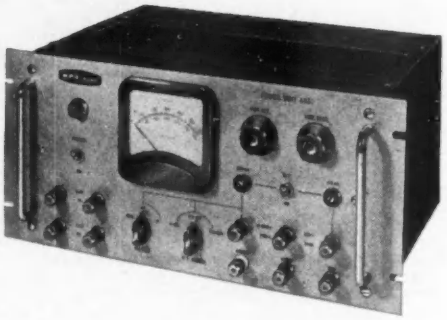

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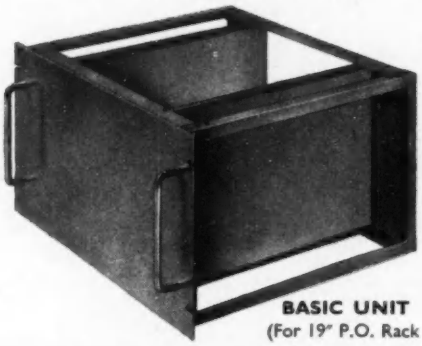

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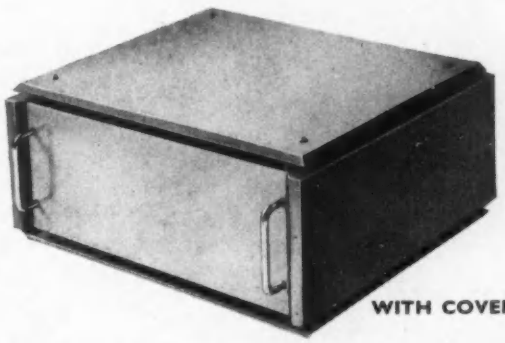

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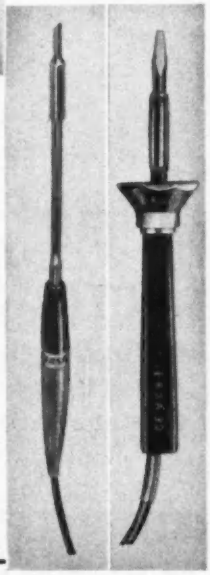

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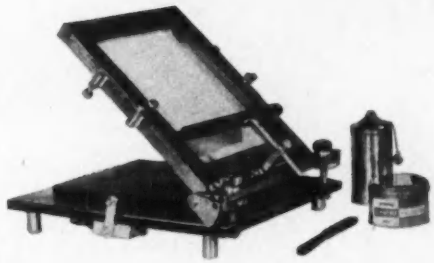

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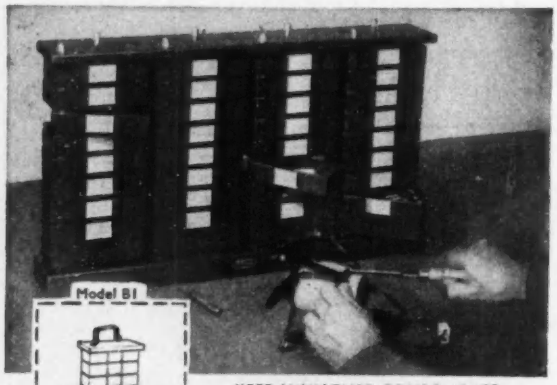

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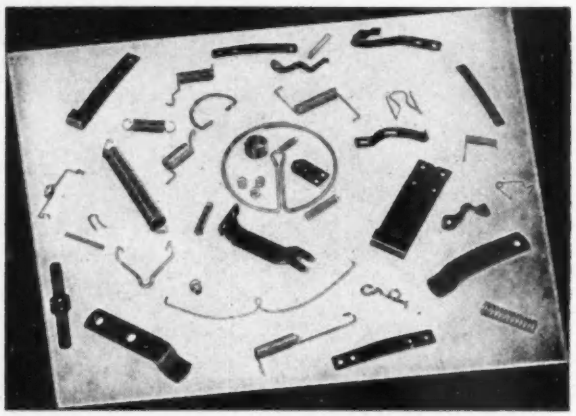

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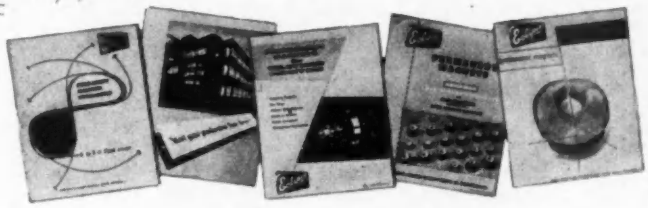

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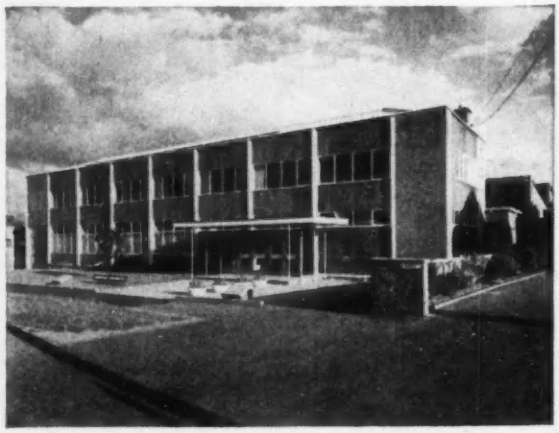

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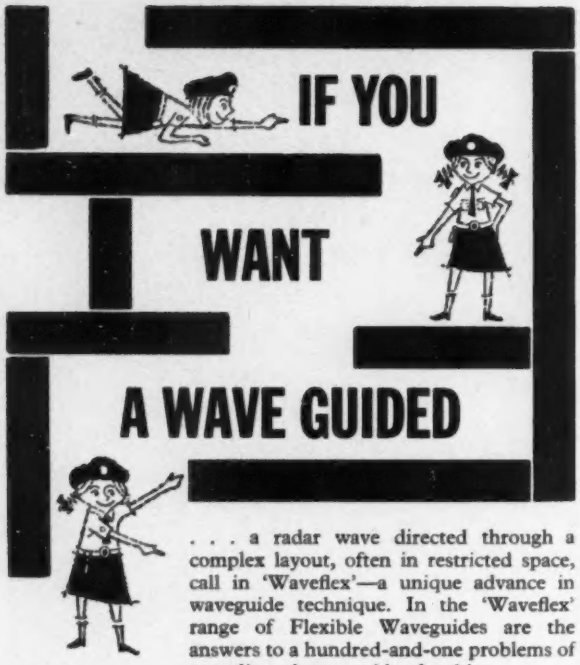

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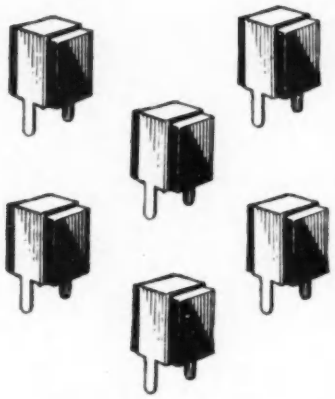

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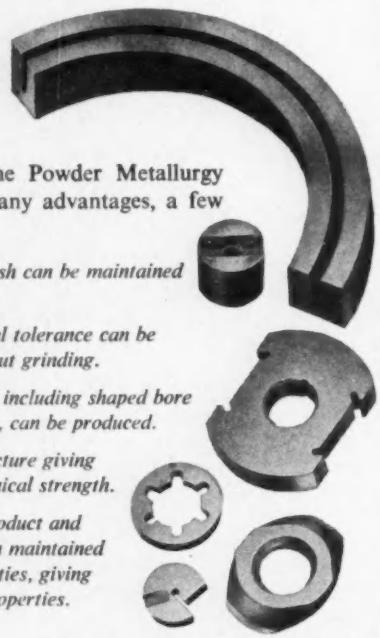

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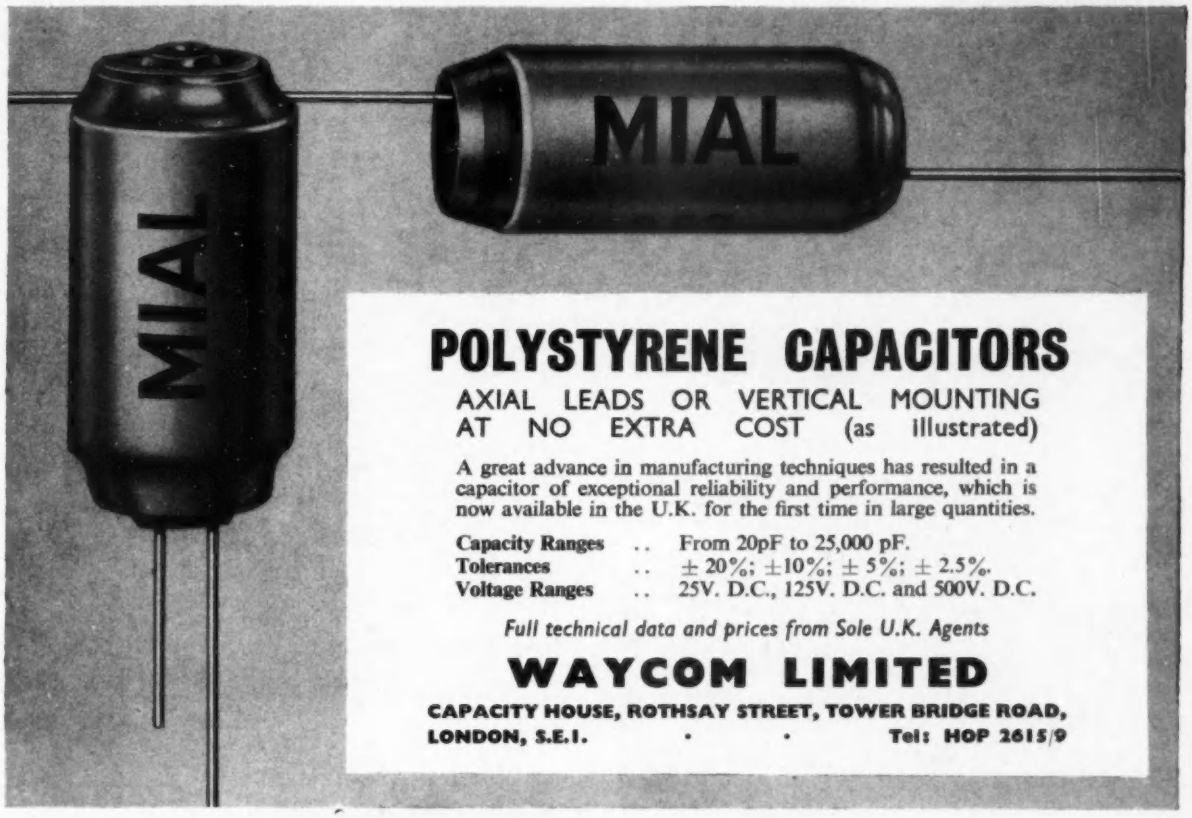

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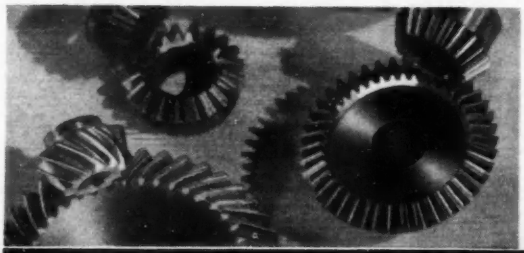

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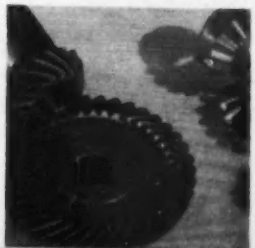

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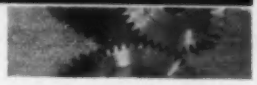

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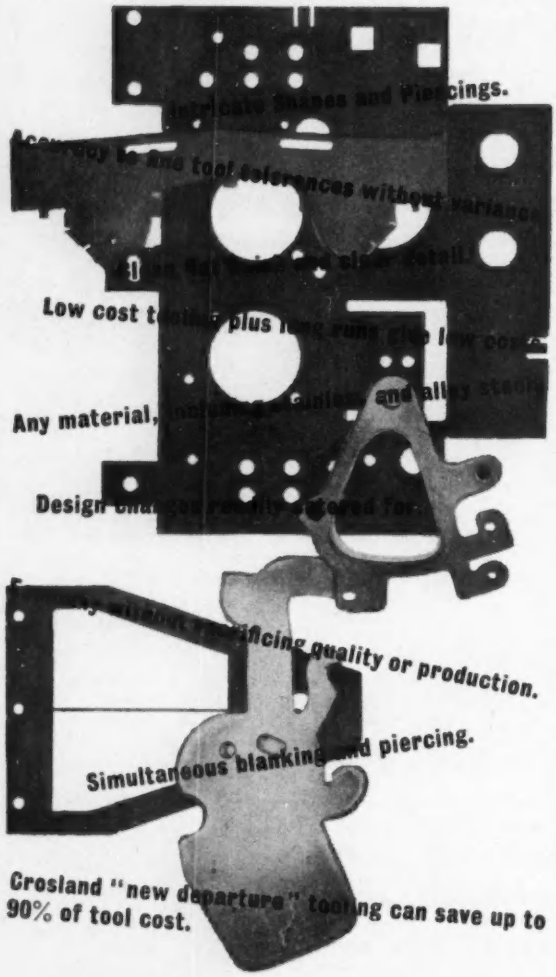

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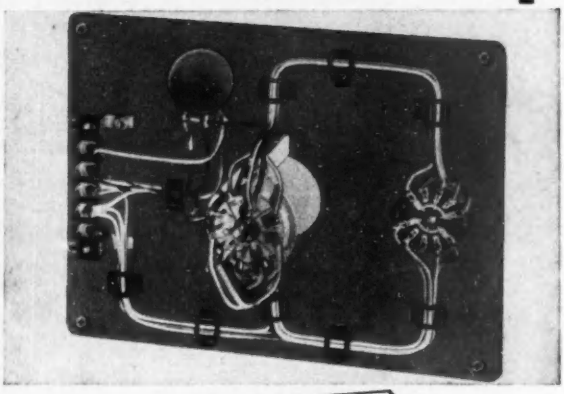

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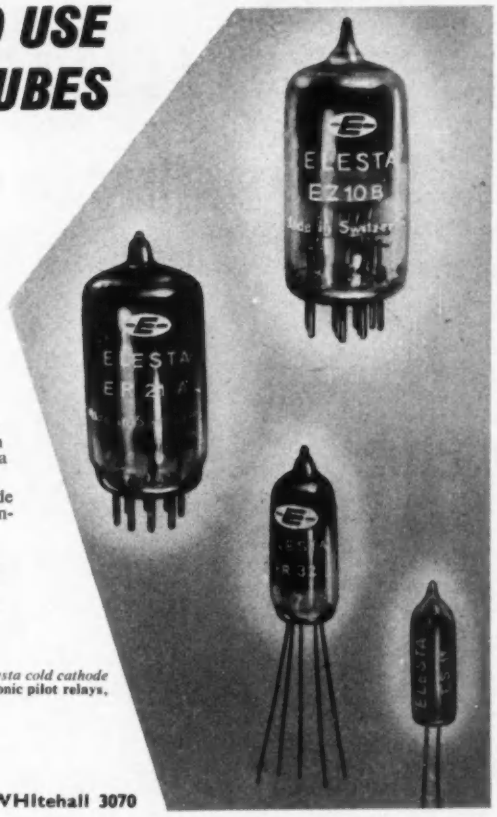

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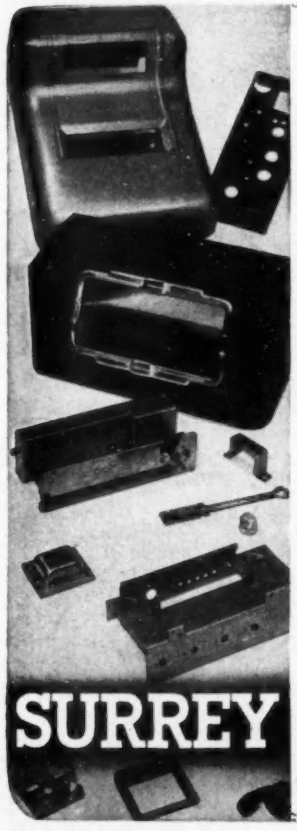

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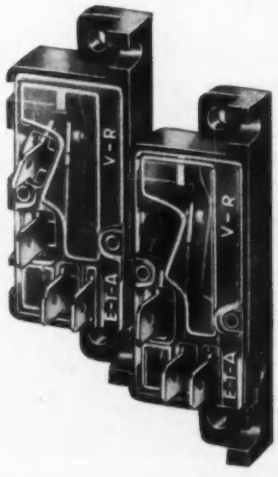

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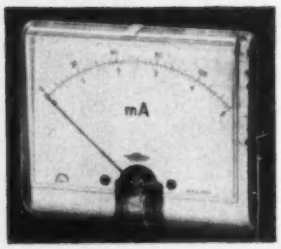

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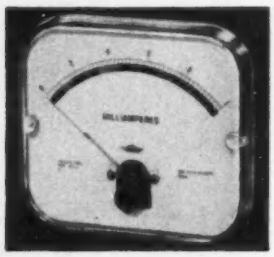

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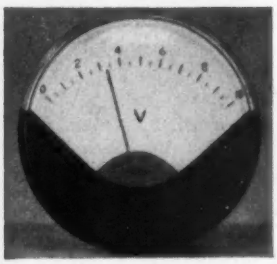

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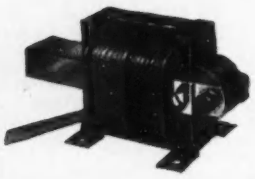

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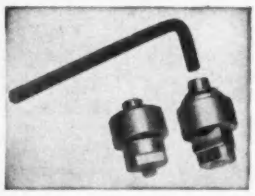

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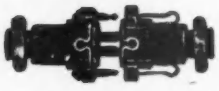

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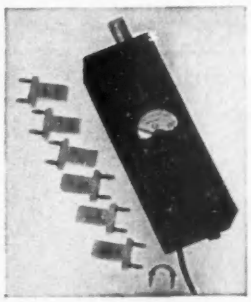

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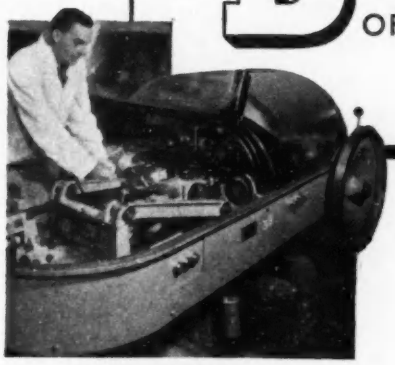

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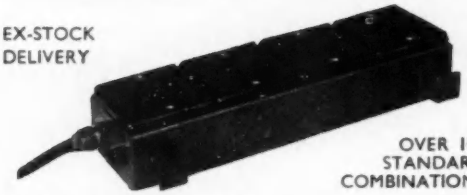

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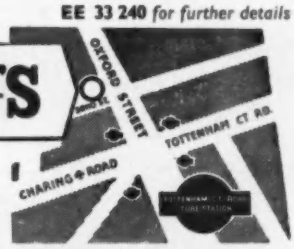

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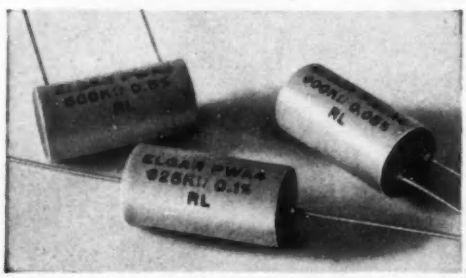

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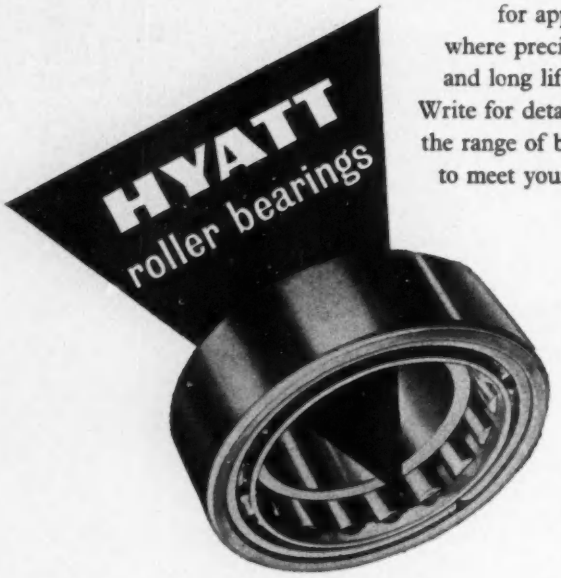

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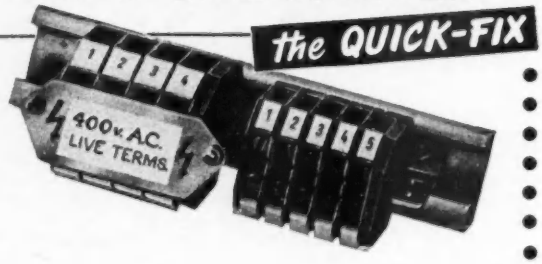

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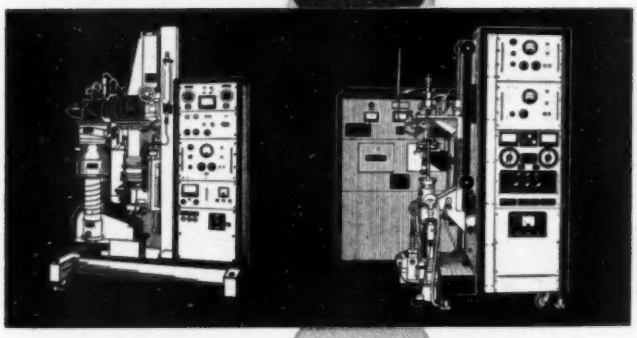

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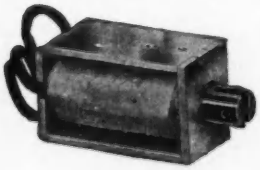

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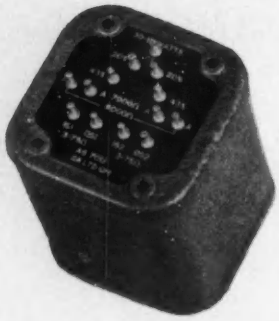

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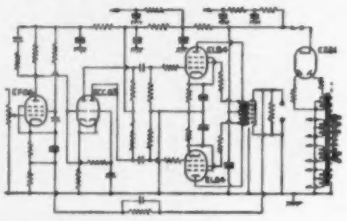

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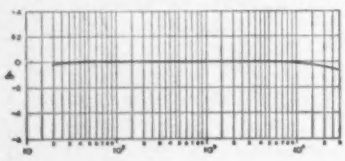
Below is reproduced the Response Curve of the AS.7012 which is typical of the whole of the Solent Series.



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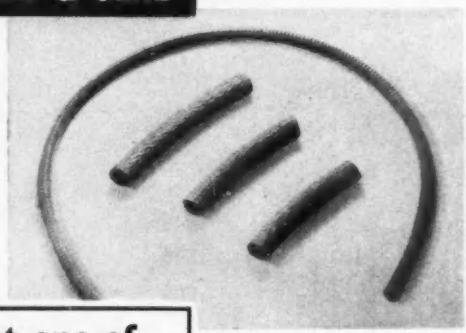

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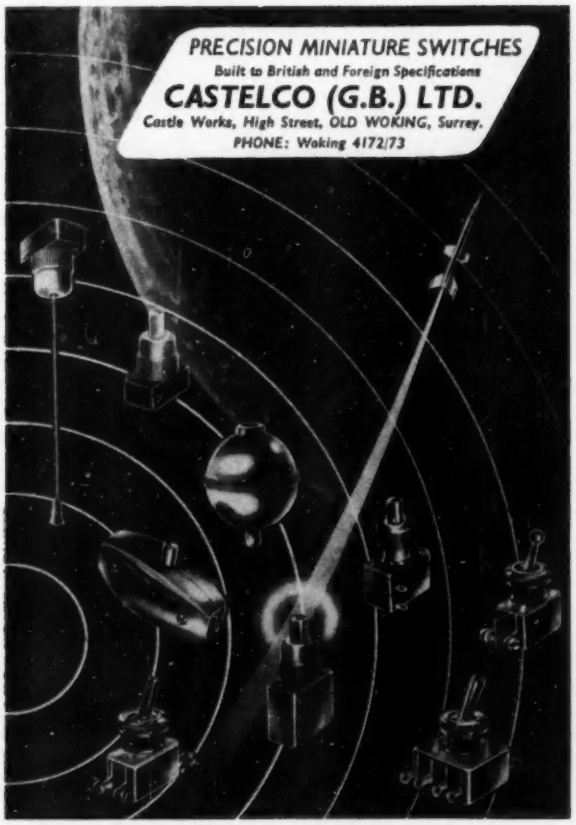
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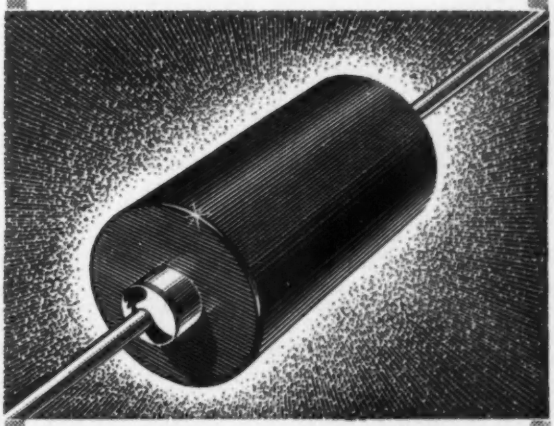

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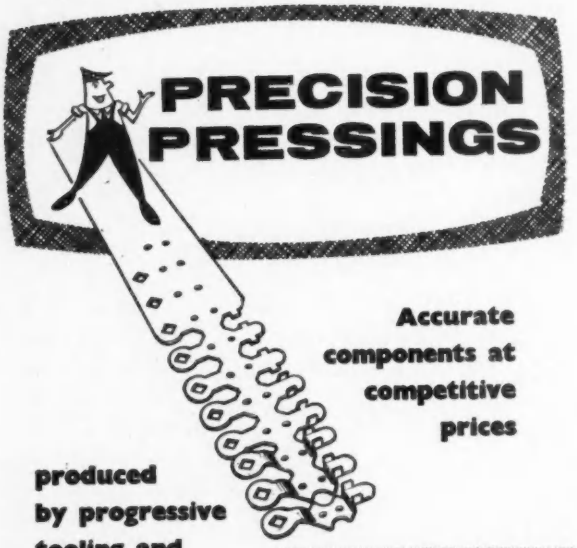

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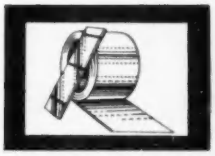

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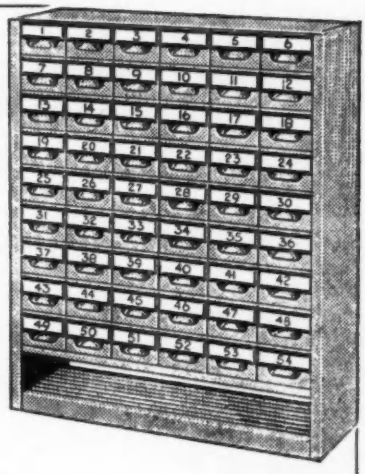

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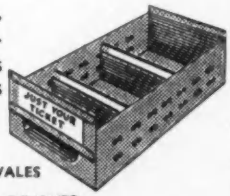

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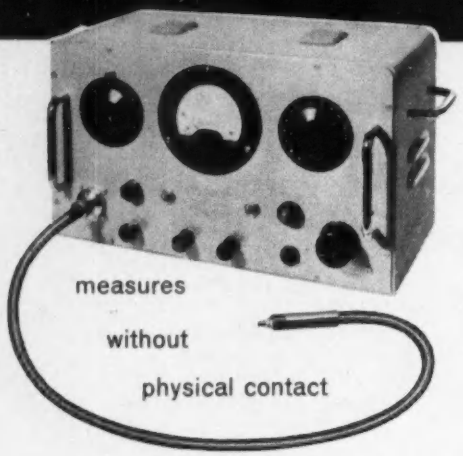

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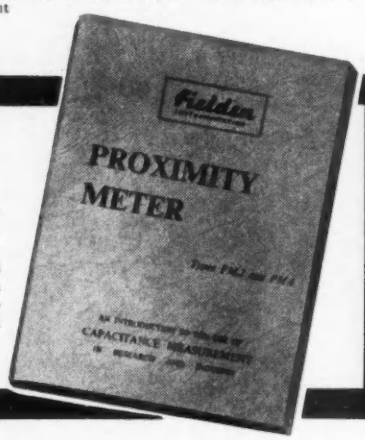

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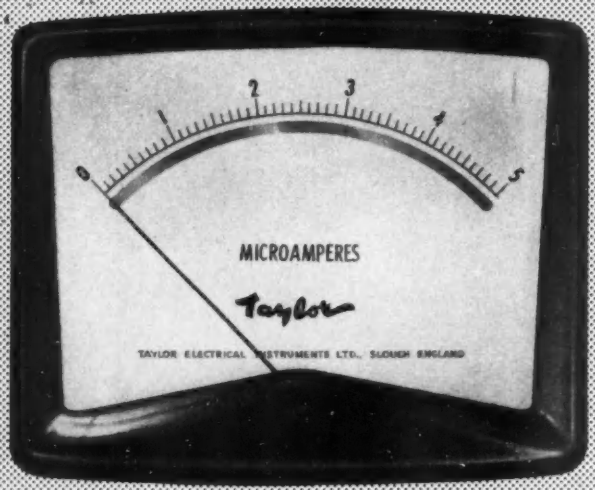

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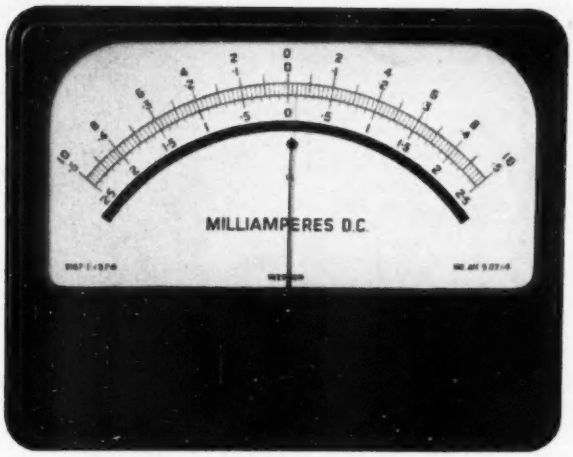

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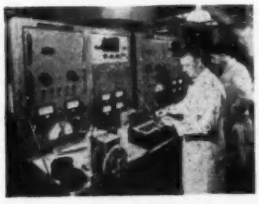

This multi-range meter, using Sangamo Weston S.157, is one of several similar instruments produced by Anders for Ultra Electronics Limited within 14 days. The meters are used in Ground Test Equipment supplied to B.O.A.C. (shown left) for testing the Ultra Engine Throttle Control fitted in Bristol Britannia Aircraft. A typical example of the quick service Anders are giving to many famous firms. Anders are indebted to Ultra Electronics Limited and B.O.A.C. for permission to illustrate this equipment.

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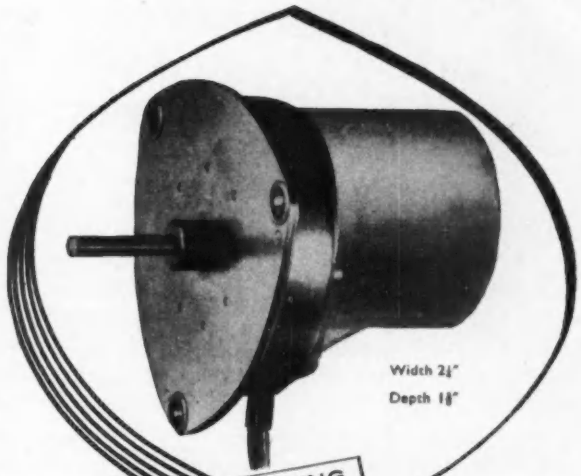

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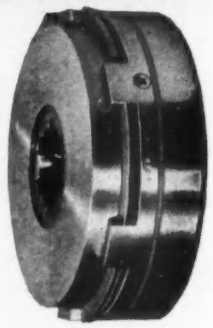

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BRITISH EMPIRE CANCER CAMPAIGN. Radiation Research. A Graduate Electrical or Electronics Engineer, age preferably 25 to 30, is required to collaborate in the development and experimental use of an electron linear accelerator, 3 cm. microwave spectroscope, and other experimental equipment which is being used to study the chemical and biological effects of microsecond pulses of radiation. Salary in accordance with qualifications and experience. Apply in writing to the Director, Research Unit in Radiobiology, Mount Vernon Hospital, Northwood, Middlesex. W 5156

CAREERS FOR RADIO TECHNICIANS in Civil Aviation. Vacancies for Radio Technicians, aged 19 or over, at Airports and Radio Stations throughout the United Kingdom, maintaining radio communication and electronic navigational aids. Fundamental knowledge of radio with some practical experience required for entry. Training given on the equipment in use. Salary approximately £670 (at 25), rising to £795. 3½ weeks' holiday with pay. Paid sick leave. Facilities to study for higher qualifications, giving good prospects of pensionable posts and promotion to grades with salary maximum £988, £1,128 and £1,388. Apply for further details to Ministry of Aviation (Est/5a), Room 755, Adelphi, John Adam Street, London, W.C.2, or any employment exchange, quoting Westminster O/N 3552. W 5106

ELECTRONIC TECHNOLOGIST required for development of equipment for automatic control of the growth of bacterial cultures by means of photo-electric balance. Experience with D.C. and pulse amplifiers necessary. Starting salary up to £1,000 according to age, qualifications and experience. 5-day week. Possibility of housing accommodation. Applications to: Administrator, Medical Research Council, Radiobiological Research Unit, Harwell, Berkshire. W 5168

LABORATORY TECHNICIAN with experience in maintenance, construction and use of apparatus for physical measurements wanted for work in the new laboratories of the Department of Mechanical Engineering, Queen Mary College (University of London), Mile End Road, E.1. Some knowledge of electronics or photography would be an advantage. Salary according to ability on scale £490 p.a. by 20/25 to possible £675. Plus London Weighting £30 to £45 according to age, and possible qualifications supplement of £30. Five day week. Four weeks annual leave. Pension scheme. Letters only to Registrar (M.M.T.), stating age, full details past experience and present work. W 5161

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE. Physicist, Engineer or Biological Scientist with interest and experience in instrument development required to work with the Professor of Epidemiology on problems connected with the measurement and physiological variables in population groups. Appointment for 2 years in first instance. Successful applicant will be seconded to the Bio-Engineering Laboratory of the Division of Human Physiology, National Institute of Medical Research. Salary scale £800-£1,000, depending on age and experience. Appointment to start June, 1961. Applications to the Dean, London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1. W 5147

MEDICAL RESEARCH UNIT requires an electronic engineer or graduate to work on the development and application of digital computer techniques for medical electronics. The work is in no sense routine and would require someone able to take considerable initiative in designing and building transistorised circuits. Salary on the Medical Research Council scale, depending on age and experience, £940-£1,300 p.a. plus superannuation. Apply stating age, qualifications, previous experience and the name of two referees to Dr. A. M. Halliday, National Hospital, Queen Square, London, W.C.1. W 5169

OFFICIAL APPOINTMENTS (Cont'd.)

AIR MINISTRY. Scientific Adviser's Department. Air Ministry require unestablished Senior Scientific, Scientific Officer and Experimental Officers in Scientific Adviser's Department. Quals. Senior Scientific and Scientific Officers should have 1st or 2nd Hons. Degree in one of the subjects specified. Experimental Officers should be ebtween 26 and 31, and have pass degree, H.N.C. or G.C.E. 'A' Level including at least one of the subjects specified. Four Scientific Officer posts at A.M. Headquarters Whitehall for Graduates in Mathematics or Physics. Post A—in Strategic Offense and Atomic Section, involving cost/effectiveness studies of offensive systems, studies on strategy of R.A.F. offensive operations, and of atomic effects and target response. Mathematician preferred. Post B—in Air Defence and Electronics Section involving cost/effectiveness studies of defensive systems and detailed electronic studies of radar, electronic counter-measures, and infra-red. Physicist preferred. Post C—in Strategic Studies and Anti-Submarine Warfare Section, involving studies of inerplay of offense and defence, and the requirements of nuclear submarine detection. Post D—in Limited War Section, involving studies of tactical aircraft, tactical weapons systems and limited form of war games in tactical sphere. Three Senior Scientific or Scientific Officer posts on staff of Operational Research Branch at Bomber Command, High Wycombe, for Graduates in Mathematics, Physics or Engineering. Post E—at Command H.Q. involving work on evaluation, use and operation of airborne and ground electronic equipment. Good electronics background required, preferably with experience on airborne and ground radar. Post F—at Command H.Q. involving work on problems of effectiveness of Medium Bomber Force and in programming and organisation of an Elliott 402 computer. Good mathematical background required. Post G—involving work on trials of Bluestreak and also work at Bomber Command Development Unit at Finningley, Yorks. Two Experimental Officers for Post H—at H.Q. Bomber Command, High Wycombe, to assist in computer programming to train other programmers and to participate in work involving bombing calculations, defect recording systems, nuclear fallout profiles, etc. Be interested in problems of data handling and have quals. in mathematics, physics or engineering. Post I—at H.Q. Technical Training Command, Brampton, Hunts. concerned with collection and analysis of data, and conducting experiments in training of technicians. Background and quals. in social sciences with some knowledge of statistics preferred but quals. and exp. in electronic engineering accentable. Salaries: National rate—Senior Scientific Officers £1,342-£1,654, Scientific Officers £738-£1,222, Exp. Officers £1,087-£1,336. £55-£65 more for posts in London. Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1 (quoting A 128/1A and appropriate Post ref.). Closing date 12th May, 1961. W 5136

CENTRAL ELECTRICITY GENERATING BOARD Eastern Division. Applications are invited for the following appointments in the Divisional Electrical Department: Fourth Assistant Engineers (Telecommunications) (S.V. No. 1468). Salary N.J.B., Class AX, Grade 9, Scale 9, £1,005-£1,245 per annum. The applicants appointed will be based at either Cockfosters (North London), Bedford, Ipswich or Luton. The salary for the post at Cockfosters will be subject to an addition of £50 per annum in respect of London Weighting. Applicants should preferably possess qualifications leading to Graduate Membership of the British Institution of Radio Engineers, or the Institution of Electrical Engineers. Consideration will, however, be given to candidates well advanced in studies for Higher National or City and Guilds Certificates. The successful applicants will be required for installation, maintenance fault clearance, testing and commissioning of a variety of telecommunications equipment, including auto-telephony, telemetering, remote control systems, power line carrier equipment, V.H.F. radio, etc. Experience in one or more of these fields is desirable. A knowledge of the Generating Board's standardised system of indications, telephony and telemetering would be an advantage. Applications, quoting Reference S.V. No. 1468, and indicating the location of the post for which they wish to be considered, stating age, qualifications, experience and present position, should be sent to the Controller, Central Electricity Generating Board, Eastern Division, West Farm Place, Chalk Lane, Cockfosters, Barnet, Herts., to arrive not later than 6th May, 1961. W 5139

PAISLEY TECHNICAL COLLEGE, George Street, Paisley. Scottish Central Institution. Electrical Engineering Department. Applications are invited from Honours Graduates with industrial experience for appointments as lecturers in (a) Electric Power Engineering and (b) Electronic Engineering. The commencing salary will depend upon experience subsequent to graduation and will increase by £50 per annum to a maximum of £1,700 per annum. Courses are provided in the Department for the London External B.Sc. Degree and the I.E.E. Part III examinations. Further particulars may be obtained from the undersigned and applications should be submitted not later than 15th May, 1961. H. N. Henry, Principal, Paisley Technical College. W 5171

EMPRESA NACIONAL DE TELECOMMUNICACIONES, Republic of Colombia, South America. A Telecommunications Engineer is required to assist the Chief English Resident Engineer in the development of the long distance telephone and telegraph services of Colombia, under the technical direction of Messrs. Preece, Cardew & Rider, Consulting Engineers. The work comprises the supervision and administration of contracts for multi-channel VHF radio links, automatic and manual telephone exchanges, subscribers telex and public telegraph automatic switching systems, etc., and includes the planning and supervision of installation works, acceptance testing of the completed installations and organisation of the subsequent maintenance arrangements. In addition to a general knowledge of telecommunications, applicants should have a thorough knowledge of automatic telephone systems and should be capable of organising and handling the actual work in the field. Preference will be given to applicants with a sound knowledge of crossbar automatic telephone exchange systems in particular. The engineer appointed to the post will normally be resident in Bogota but will be required to travel to other parts of Colombia in the course of his duties. Actual travelling expenses plus an adequate living allowance will be paid for these trips. Travel between the principal cities of Colombia is rapid, as regular air services are available. The engineer will be expected to study and to learn the Spanish language. The period of engagement will be three years in the first instance. Salary will be dependent upon qualifications and experience but will be of the order of £375 per month, payable mainly in U.S. dollars and partly in Colombian pesos. Fuller details will be given to applicants selected for interview. In addition, social benefits recognised by the Colombian Labour Legislation will be paid in Colombian pesos. Free passsges to Bogota will be provided for the successful applicant and his family, up to a maximum of five persons including himself, together with free return passages to England on the satisfactory conclusion of the contract. Applications giving full details of training and experience together with copies of any relevant testimonials should be submitted to the Consulting Engineers, Messrs. Preece, Cardew & Rider, 8-12, Queen Anne's Gate, London, S.W.1. W 5167

LANCHESTER COLLEGE OF TECHANOLOGY, Coventry Principal : J. Richmond, B.Sc.,(Eng.), Ph.D., M.I.Mech.E. Appointment of Additional Academic Staff. Applications invited for following posts, duties to commence 1st September, 1961, or from date to be arranged. Department of Electrical Engineering (Head of Department: E. A. Hanney, M.Eng., Ph.D., M.I.Mech.E., M.Brit. I.R.E.). One Principal Lecturer: Two Senior Lecturers: One Lecturer: to teach to H.N.C., Part III I.E.E. and degree standard. Opportunities exist in electronic engineering, control engineering, heavy current work and electro-technology. Candidates should normally hold University degree or Diploma in Technology and a professional qualification. Applicants who do not meet these requirements may be eligible by virtue of outstanding experience or other qualities. Industrial or professional experience is necessary, while some previous teaching or research experience would be an advantage. The College is largely housed in new buildings occupied in 1960. The remaining buildings will be occupied during 1963. Equipment and general facilities in the new buildings are excellent and a real opportunity exists for the staff to take part in the many further educational developments which are projected in close and growing co-operation with industry. An outstanding feature of all Departments are many well-supported post graduate courses of lectures. It is hoped that several Dip. Tech. courses will be offered from September, 1961. All staff are encouraged to undertake research and/or consulting work. Salaries (now under review):—Principal Lecturers £1,750×£50—£1,900 p.a. Senior Lecturers £1,550×£50—£1,750 p.a. Lecturers £1,370 ×£35 (4)×£40 (1)—£1,550 p.a. In certain circumstances a candidate may be paid commencing salary above minimum of scale. Further particulars and application forms from the Registrar, Lanchester College of Technology, Priory Street, Coventry, to whom applications should be submitted within 12 days of the appearance of this advertisement. W. L. Chinn, Director of Education. W 5159

LONDON COUNTY COUNCIL South East London Technical College, Lewisham Way, S.E.4. Department of Electrical Engineering. Applications are invited for Lecturers and Assistant Lecturers (Grade B) in Automatic Telephony, Radio Communication and Light Current Electrical Engineering, including Instrumentation. Candidates should be well qualified, have industrial experience and preferably some teaching experience. The Department offers Full-time, Sandwich, Part-time Day and Evening Courses. Successful candidates may be required to teach up to Part III I.E.E. and/or C. & G. Telecommunications supplementary studies standard. Salary scales: (i) Lecturers £1,408 to £1,601 with possible entry above the minimum. (ii) Assistant Lecturers (Grade B) £738 to £1,486. Point of entry and maximum dependent on relevant industrial or teaching experience and qualifications. Application forms from the Secretary, returnable within two weeks, quoting (FE.3a/E/950/4). W 5172

MIDDLESEX COUNTY COUNCIL. Education Committee. Twickenham Technical College, Egerton Road, Twickenham. Principal: J. P. Wolfenden, M.Sc., M.I.E.E. Department of Electrical Engineering and Physics. Applications are invited from qualified engineers for two new posts of Lecturer. Duties to commence 1st September, 1961. (1) Lecturer in Electronics with experience in Transistor applications. (2) Lecturer in Electrical Power with experience in the control of Electrical machines. The work of the department is rapidly expanding and includes Higher National Certificate, Higher National Diploma, Part III Examination of the Institution of Electrical Engineers, Post Graduate and Special Lecture courses. Large extensions opened in 1960 have provided well equipped laboratories and workshops. Candidates should possess a degree or graduate equivalent and have had suitable industrial experience. Part-time or full-time teaching experience is desirable but not essential. Salary within the range £1,408 to £1,601 per annum. Further particulars and application forms may be obtained from the Principal to whom completed forms should be returned within 14 days. C. E. Gurr, M.Sc., Ph.D., Chief Education Officer. W 5157

OXFORD UNIVERSITY. Senior Electronics Technician required now in the Department of Physical Chemistry for the development, construction and maintenance of a wide range of electronic research equipment. Commencing salary deper ding on age and experience in the range £800-£1,000. Apply: Secretary, Physical Chemistry Laboratory, South Parks Road, Oxford. W 2030

PATENT EXAMINERS and Patent Officers Pensionable posts for men or women for work on the examination of Patent applications. Age at least 21 and under 29 (36 for Examiners) on 31.12.61, with extesnion for regular Forces service and Overseas Civil Service. Qualifications: normally a degree, or a Diploma in Technology, with first or second class honours in physics, chemistry, engineering or mathematics, or equivalent attainment, or professional qualification, e.g. A.M.I.C.E., A.M.I.Mech.E., A.M.I.E.E., A.R.I.C., A.Inst.P. Inner London Salary £793 to £1,719; provision for starting pay above minimum. Promotion prospects. Write Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting S/128/61, and stating date of birth. W 5137

PLYMOUTH AND DEVONPORT TECHNICAL COLLEGE. Principal: E. Bailey, B.Sc., F.R.I.C., A.M.I.Chem.E. Required, as soon as possible, Assistant Lecturer Grade A for Radio Officers courses with opportunities for taking other radio and electrical courses within the Electrical Engineering Department. Candidates should hold a First Class P.M.G. Wireless Telegraphy Certificate and M.O.T. Radar Maintenance certificate. Seagoing and/or teaching experience are added qualifications. Salary Burnham Scale £520×£27/10/0 to £1,000 per annum with additions for approved experience, qualifications and training. Forms and particulars (s.a.e.) from Clerk to the Governors, Education Offices, Cobourg Street, Plymouth, to whom they should be returned as soon as possible. W 5140

OFFICIAL APPOINTMENTS (Cont'd.)

RESEARCH FELLOWSHIPS. R.A.E. Ministry of Aviation invites applications for a limited number of Senior and Junior Research Fellowships tenable for three years at the Royal Aircraft Establishment, Farnborough, Hants, or Bedford. Fellows will be required to carry out Fundamental Research in connection with advanced rocket and aircraft projects. The scientific fields covered include aerodynamics, thermodynamics, aircraft and missile structures, guidance and control techniques, new synthetic polymers and their properties, electronics involving solid state physics, semi-conductors, propagation, physics and chemistry of surfaces, gas discharge physics, microwave physics, etc. Subjects will be selected according to the training and experience of the Fellows and the needs of the Establishment. Candidates must be British subjects with normally either a First or Second Class Honours Degree in the Natural Sciences, Mathematics or Engineering and with evidence of a very high standard of ability in research. Exceptionally a candidate without the academic requirements but who can produce evidence of outstanding ability in research may be admitted. At least two years' post-graduate research experience required for J.R.F. (age preferably 23-26) and at least three years for S.R.F. (age preferably 26-30). Remuneration according to individual merit on ranges £1,325-£1,640 (S.R.F.) £910-£1,220 (J.R.F.). Superannuation under F.S.S.U. At expiry of a Fellowship the holder, if of suitable age, can be considered for an established (pensionable) post through a Civil Service Commission Open Competition. Application forms and booklets obtainable from the Director, R.A.E., Farnborough, Hants, for return by 8th May, 1961. Overseas candidates should send written applications stating age, nationality and place of birth of self and parents, educational and academic qualifications, appointments held and research experience. W 5148

RESEARCH FELLOWSHIPS. R.R.E. Ministry of Aviation invites applications for Senior and Junior Research Fellowships tenable for three years at the Royal Radar Establishment, Malvern, commencing Autumn, 1961. There is a considerable Choice of Subjects within the fields of interest to the Establishment. These include experimental and theoretical research in low temperature physics, electrical and optical properties of semi-conductors, infra-red spectroscopy, micro-wave physics, electronics, radio-astronomy, shock waves, ionisation phenomena in gases, physics of upper atmosphere. Candidates must be British subjects with normally First or Second Class Honours degree in an appropriate subject, with evidence of a very high standard of ability in research. Exceptionally, a candidate without the requisite academic qualifications, but who can produce evidence of outstanding ability in research may be admitted. At least two years' post-graduate experience required for J.R.F. (age preferably 23-26) and three years for S.R.F. (age preferably 26-30). Remuneration according to individual merit in ranges £1,325-£1,640 (S.R.F.) £910-£1,220 (J.R.F.) a year. Superannuation under F.S.S.U. At expiry of Fellowship the holder, if of suitable age, can be considered for an established (pensionable) post through a Civil Service Commission Open Competition. Application forms and booklet from the Director R.R.E., Malvern, Worcestershire, to whom they must be returned by 8th May, 1961. W 5149

ROYAL MILITARY COLLEGE OF SCIENCE, Shrivenham, Berkshire, requires Graduate Demonstrators (Male) in Department of Electrical and Instrument Technology. Teaching at University level. To assist in supervision of Students' laboratory work and in reseach by Staff and Students. Extensive well-equipped laboratories. Opportunities to engage in personal research towards higher degree in fields of electrical engineering, electronics, computing and servo-mechanisms. Quals. 1st and 2nd class Honours degree or equiv. in Electrical Engineering or Physics. Salary range: £754 to £910, superannuation under F.S.S.U. Appointments normally 3 years but may be extended. Opportunities exist for promotion to grades of Lecturer and higher grades. Quarters available for single men; possibility of houses for married men. Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting D.200/1A. Closing date 13 May 1961. W 5153

ROYAL OBSERVATORY EDINBURGH SEISMOLOGY. Applications are invited for a post of Electronics and Instrument Engineer (Experimental Officer) to take part in research programmes in a new group working on new instrumentation and digital data-handling in seismology. Candidates should normally be university graduates or graduate members of a professional institute in physics or electrical or mechanical engineering or equivalent. Versatility and ability to work independently are required in this now rapidly evolving subject. Age: 26 or over. Salary: £1,087-£1,336 commencing at minimum. The post is unpensionable in first instance but opportunities to gain pensionable post will occur. Further particulars and application form from Establishment Officer, Scottish Home Department, Room 364, St. Andrew's House, Edinburgh, 1. Closing date 23rd May, 1961. W 5165

ROYAL NAVAL SCIENTIFIC SERVICE Admiralty require Senior Scientific Officers/Scientific Officers at an Underwater Weapons Establishment, Portland, Dorset (Ref. C69/1A). (1) Mechanical Engineer, specialised in thermodynamics with experience in internal combustion engine research and/or rocket propulsion field. Minimum 5 years' experience in either expected. Some experience in appropriate instrumentation essential with design study work on components of rocket systems or other propulsion gear. Turbine design experience advantageous. (2) Mechanical Engineer with bias for one or more of: (i) hydraulically operated mechanisms, including servo-control; (ii) mechanics of machines (theory and practice); (iii) hydro- (or aero-) dynamics of fairly elementary character. (3) Hydrodynamicist (or Aeronautical Engineer), with some years' experience for work on torpedo dynamics. (4) Mechanical Engineers (Servo-mechanisms, gyro design and develop), Electronic Engineers (Electronics/Design), Mathematicians (Operational research and theoretical physics), Physicist (acoustics). B: Government Communications H.Q., Cheltenham (Ref. A43/1A). Physicists (Telecommunications), Mathematicians, Electronic Engineers (Electronics/Radar): Telecommunications and Radio). C: Naval Construction Research Establishment, Dunfermline (Ref. C70/1A). Structural and Mechanical Engineers, Mathematical Physicists and Mathematicians, for teams engaged on research problems of structural strength, effects of conventional and nuclear weapons and development of new structural materials. Excellent opportunities and good prospects for promotion. D: Admiralty Compass Observatory, Slough (Ref. D47/1A) Electrical or Mechanical Engineers or Physicists interested in gyro-techniques, servo-mechanisms or electronics. Qualifications for all posts: 1st or 2nd Class Honours Degree or equivalent in appropriate subject. Must normally be natural born British subjects of natural born British parents. S.S.O.'s must have had minimum 3 years' post-graduate experience and be not less than 26 years of age. Salaries: (A) S.S.O., £1,302-£1,604; S.O., £717-£1,186. (B, C, D) S.S.O., £1,342-£1,654; S.O., £738-£1,222. Appointments unestablished (with F.S.S.U. benefits) but opportunities for those between 21 and 32 to compete for established posts. Forms from Ministry of Labour, Technical & Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate reference and post. W 5080

THE COUNTY BOROUGH OF CROYDON EDUCATION COMMITTEE invite applications from suitably qualified teachers for the following vacancy which will become tenable in September: Croydon Technical College, Fairfield, Croydon. Principal: D. A. Green, M.B.E., B.Sc., M.Ed. Department of Electrical Engineering. Graduate Lecturer mainly for light current subjects up to H.N.C. level. Industrial experience in some branch of electronics would be welcomed. The ability to assist in teaching Radio and Television Servicing up to the C.G.L.I. Final would be an additional recommendation. Salary according to the Burnham Technical Scale for Lecturers with London Area Allowance. Further particulars and forms of application may be obtained from the Chief Education Officer, Education Offices, Katharine Street, Croydon and should be returned to the Principal not later than the first post on Wednesday, 10th May, 1961. W 5173

THE SCIENTIFIC CIVIL SERVICE needs men and women for pensionable posts as (a) Experimental Officers and (b) Assistant Experimental Officers in Mathematics, Physics, Meteorology, Chemistry, Metallurgy, Biological Sciences, Engineering, Miscellaneous (Geology, Library and Technical Information Services). Candidates must, on 31.12.61, be at least 26 and normally under 31 for (a), and at least 18 and normally under 28 for (b). Qualifications should normally include H.S.C., or G.C.E., or equivalent, or H.N.C., a University degree, or a Diploma in Technology. Provisional admission if taking examinations in 1961. London salary scale (a) £1,117-£1,376; (b) £465 10s. (at 18) to £826 (26 or over) rising to £1,009. Promotion prospects. Further education facilities. Write Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting S/94-95/61. W 5154

THE SCIENTIFIC CIVIL SERVICE needs men and women for pensionable posts as Assistants (Scientific). Ages at least 17 and normally under 27 on 31.12.61 with appropriate educational or technical qualifications (normally G.C.E. with passes at 'O' or 'A' level in 4 distinct subjects including English language and a scientific or mathematical subject, or O.N.C., or equivalent qualifications) and at least 1 year's experience in: (i) engineering or physical sciences, or (ii) chemistry, bio-chemistry or metallurgy, or (iii) biological sciences, or (iv) geology, meteorology, or skilled work in laboratory crafts such as glass-blowing. National salary from £354 (at 17) to £551 (at 25 or over) rising to £723. Promotion prospects. 5-day week generally. Write Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting S/59/61. W 5163

TEMPORARY OFFICERS (Grade II or III according to quals.) in Ministry of Defence for special research work. Research or trials exp. in ballistics, electronics or guided weapons is required. A knowledge of the guided weapons industry and foreign languages would be advantageous. Salary scales Grade III £458-£1,154, Grade II £1,222-£1,430, plus London Weighting. Write giving age, quals. and exp. to Manager (PE.73), Ministry of Labour, Professional and Executive Register, Atlantic House, Farringdon St., London, E.C.4. W 5150

SITUATIONS VACANT

ASSISTANT TO THE CHIEF ENGINEER. Painton & Co. Ltd., manufacturers of high-quality components for the Electronics Industry, are expanding their activities and wish to appoint an Assistant to the Chief Engineer. Applicants must be graduates in Physics or Electrical Engineering, have experience in the design and development of Electronic Components and be able to carry executive authority. This is a staff appointment with Superannuation Scheme. Applications to the Personnel Officer, Kingsthorpe, Northampton. W 5125

ASSOCIATED ELECTRICAL INDUSTRIES LTD., Electronic Apparatus Division, Trafford Park, Manchester, 17. Testers urgently required for interesting work on Ground Radar, Servo-Control and Computer systems. Technical qualifications an advantage. There are excellent opportunities available for suitable applicants. Why not write in now for application form and conditions, to The Employment Supervisor, A.E.I. (Manchester) Ltd., Trafford Park, Manchester, 17. W 5111

DEVON COAST AREA now offers employment in addition to all the well known attractions of the West Country. Senior Electronic Engineers, with experience of transistor circuitry, are invited to apply for a post in a laboratory engaged in the design of a wide range of electronic instruments. Academic qualifications are desirable, but the most important qualification is the ability to achieve results. The successful candidate will have the opportunity of living in the heart of the most popular holiday area of the British Isles. Write in confidence to the General Manager, Hatfield Instruments Ltd., Burrington Way, Plymouth. W 3034

ELECTRONIC DESIGN/Development Engineer required by expanding Company. Knowledge of supervision on small production runs desirable. Candidates should be conversant with the Services Approved Components system. Degree or H.N.C. standard essential. Knowledge of sound mechanical design applicable to instrumentation an advantage. Salary will be commensurate with the applicant's qualifications and/or experience. Please apply in writing to Technical Director, Kenure Holt Electronics Ltd., Boyn Valley Road, Maidenhead, Berks. W 2032

ELECTRONIC DEVELOPMENT Engineers required. Experienced in wide Band Amplifiers and Time Bases for Oscilloscopes. Salary commensurate with experience and qualifications, commencing £900-£1,250. Write Dartronic Ltd., 3-7, Windmill Lane, E.15. W 2035

CLASSIFIED ADVERTISEMENTS
continued on page 210

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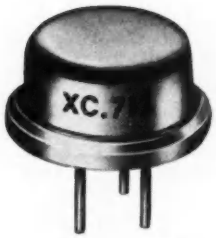

MEDIUM POWER TYPES

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		XC703	XC713	XC723
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Maximum emitter/base voltage (volts)		12	12	10
Minimum h_{fe}	(V_{ce} = 4V, I_c = 200 mA)	15	—	—
	(V_{ce} = 4V, I_c = 750 mA)	—	15	—
	(V_{ce} = 4V, I_c = 1.5 A)	—	—	10
Average f_α	(V_{cb} = 28V, I_c = 5 mA) (Mc/s)	1.5	—	—
	(V_{cb} = 28V, I_c = 5 mA) (Mc/s)	—	1.25	—
	(V_{cb} = 12V, I_c = 100 mA) (Mc/s)	—	—	1

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SITUATIONS VACANT (Cont'd.)

ELECTRONIC ENGINEERS and technicians with several years' experience are required for development work on valve and semi-conductor circuitry and electro-mechanical instruments. The posts are permanent and pensionable with commencing salary of £900 to £1,300 (or more) depending on qualification and experience. Please write giving full details to New Electronic Products Limited, 360, Kennington Road, S.E.11. W 5158

ELECTRONIC ENGINEER. We have a vacancy for an engineer to work on the development of new nuclear electronic equipment. A sound theoretical knowledge is essential with qualification to H.N.C. or equivalent level, preferably coupled with some experience in pulse techniques and transistor circuit design. Further details from the Personnel Manager, Plessey Nucleonics Limited, Weedon Road, Northampton. W 5174

ELECTRONIC PROJECT ENGINEER required for interesting work in small unit of large Group. V.H.F. and transistor experience coupled with ability to rapidly finalise projects is a definite asset. Good salary and working conditions. H.N.C. normal minimum qualifications. Communications (Air) Ltd., Half Moon Street, Bagshot, Surrey. Telephone: 3085. W 358

ELECTRONIC RESEARCH. Electronic Engineers and Physicists required for interesting research work in a variety of fields at a small research establishment, with the backing of a large industrial organisation. The work is centred on a country house ideally situated for easy access to the New Forest and a large part of the South Coast as well as to London. Very pleasant working conditions, an active Social Club with many indoor and outdoor facilities and a wide choice of types of residential area are additional features. Fields of interest include general circuit work, microwaves, digital and analogue computer and storage techniques, data reduction and analysis, semiconductor applications and noise and information theory. Salaries are related more to ability and originality than to direct responsibility and for the right type of person compare favourably with those obtainable elsewhere. In the first instance they will lie in the range £750 to £2,000 p.a. depending on age, experience and qualifications. Applications giving this information should be forwarded initially to: The Personnel Manager, The Plessey Company Limited, Roke Manor, Romsey, Hants. W 5138

LOUIS NEWMARK LIMITED, leading company in the design of auto pilots for helicopters are expanding their facilities at their Development Laboratories at Croydon and have the following vacancies to be filled immediately. Engineers and Assistant Engineers with degree or H.N.C. and experience in the field of light electrical engineering, electronics, electro mechanical devices or semi conductors, to work on the development, installation and flight testing of automatic pilots. Salary commensurate with experience. Pension Scheme. Apply in writing, giving full particulars, to: Personnel Officer, Louis Newmark Ltd., Prefect Works, Stafford Road, Croydon, Surrey. W 351

ELECTRONICS AND COMMUNICATIONS. Developments during the last few years have taken A.C.E. Limited into the fields of electronics, remote control, telecommunications and systems design. This work is complimentary to the Company's extensive experience in process control and automation. Plans have been made to extend this activity and a very good opportunity exists for an Electronics Engineer with some experience of communications and telemetering to join the organisation. His work would include assessment of system requirements, specification of equipment and specialist advice to process control engineers. We envisage a man of over 30 at a commencing salary in the range of £1,300-£1,700 p.a. plus the usual benefits. A.C.E. Limited is a subsidiary company in the John Brown organisation. Please write to: M. P. Atkinson, Chief Engineer, Automatic Control Engineering Limited, Roxby Place, Seagrave Road, Fulham, S.W.6. W 5152

ELECTRONIC TEST ENGINEERS AND TESTERS. Light Engineering Company in the Midlands is requiring the above for the testing of Electronic Equipment on Government Contracts and Commercial Television. Applicants with a knowledge of this type of testing, and wishing to obtain well-paid positions, should apply stating qualifications and experience to the Personnel Manager, Box No. W 5151.

IMPERIAL CHEMICAL INDUSTRIES (Dyestuffs Division) Limited, have a vacancy for an Assistant Technical Officer to help in developing new ultrasonic and microwave techniques for the chemical industry. Applicants should have a Pass degree in physics or the H.N.C. in physics or electronics, and appropriate practical experience in the electrical industry would be an advantage. The successful candidate will be located initially at Welwyn, but will subsequently move to the Division's Research Department at Blackley, Manchester. The Company operates a 5-day, 37½ hour week, a Pension Fund and an Employee's Profit Sharing Scheme. Application forms may be obtained from Personnel Services, I.C.I. Limited, Akers Research Laboratories, The Frythe, Welwyn, Herts. W 5142

RANK PRECISION INDUSTRIES LIMITED. Central Research Laboratories have a vacancy for a Development Engineer to work on problems connected with Computer Output Printers and recording devices. Electro-mechanical, Optical and Hydraulic principles are involved in these developments. Applicants should have experience in one or more of these fields and a minimum qualification of H.N.C. or equivalent. A staff pension scheme is in operation and salaries are reviewed annually. Please apply in writing, giving details of qualifications and career so far to: The Laboratory Manager, Rank Precision Industries Ltd., Sulgrave Road, Hammersmith, London, W.6. W 5162

OVERSEAS. Electronic Technicians are required by an Oil Exploration Company with Headquarters in the U.K. Men should be single on joining. Work will include the maintaining and operating of field equipment often under conditions of desert, jungle, and swamp. The equivalent of an H.N.C., with practical experience in electronics, is essential. Tours overseas are of up to two years followed by home leave. Write with full particulars, covering any time spent in the Forces, to Box No. W 356.

SENIOR SALES ENGINEER. Machine Tool Control Equipment. Airmec Ltd. require a man of exceptional drive to take over the marketing of their AUTOSET Machine Tool Control Equipment. This is a pioneer position and the successful applicant must be prepared to accept eventual responsibility for all publicity, sales, customer liaison and market research connected with the AUTOSET. It is envisaged he will form the nucleus of a separate sales department and from the start he will be directly responsible to the Sales Director. Applicants must have had experience of Machine Tool Control equipment and should be aware of the pre-eminent position of the AUTOSET in this market. A generous salary with expenses and car allowance will be paid to the right man. Write giving full particulars of experience, qualifications, and present salary to the Personnel Officer, Airmec Limited, High Wycombe. (2501-7). W 5166

SENIOR DEVELOPMENT ENGINEER required for work on laboratory and industrial instruments for control systems. Applicants should hold a Degree, Dip.-Tech., or H.N.D. with a sound academic knowledge of control systems and a minimum of 3 years' experience in electronic instrumentation, servo-mechanisms or analogue computing units. Experience in transistor circuit design would be an advantage. The position will involve working in collaboration with consultants and developing basic ideas for instruments to the production stage with the assistance of a small team of technicians. The salary will be about £1,500 p.a. The working location is Crowborough, Sussex. The company is a young one but intends to grow. Apply to the Managing Director, Feedback Ltd., Crowborough, Sussex. W 5126

W. H. ALLEN SONS & CO. LTD. require a Senior Servomechanisms Engineer. Applicants must have a sound knowledge of servo theory and be experienced in the design of circuitry using transistors. At least 5 years' experience, a degree or good H.N.C. are the minimum qualifications. Age 28-45. Good prospects are open to the right man. Write for application form and conditions of service, etc., to: The Personnel Manager (Ref. 1007/3/2), Queens Engineering Works, Bedford. W 5117

CLASSIFIED ADVERTISEMENTS
continued on page 212

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REQUIRE SENIOR ELECTRONIC ENGINEERS WITH SEMICONDUCTOR EXPERIENCE

Texas Instruments have recently moved into the most modern semiconductor plant in the country. This continuing expansion has created further vacancies in senior positions for experienced engineers.
Applications are invited from men or women with degrees in physics or electrical engineering who have several years' experience in the use or evaluation of semiconductor devices.
The positions are with the following groups:

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This group specialises in developing test methods for semiconductor devices; advising device engineers on the electrical characteristics of products under development; preparing information for data sheets and test specifications; advising customers on the ratings and characteristics of our products.

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Silicon Mesa and Epitaxial Mesa Transistors
Grown Junction and Diffused Small Signal
Medium Power, Power and High Power Transistors
Small Signal Silicon and Germanium Alloy Transistors
Germanium Alloy Power and High Power Transistors

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This group specialises in advising customers on the use of our complete range of products, both directly and by means of published reports and articles. The work includes investigation of specific customers' problems and more long-term development of new circuits.

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Engineers are required to work in the Circuit Applications Group, with experience in the applications of transistors and diodes in one or more of the following fields:
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F.M. Tuners
Television Receivers
H.F. Power Output Stages
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Audio Amplifiers
Tunnel Diode Amplifiers and Oscillators

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Engineers are required to work in the Circuit Applications Group, with experience in the applications of transistors and diodes in one or more of the following fields:
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A.C. Amplifiers
Operational Amplifiers
Machine Control
Converters and Inverters
Semiconductor Transducers

Please apply in writing, giving details of education and experience quoting Reference number 510/C151 E.E. to

The Personnel Manager, TEXAS INSTRUMENTS LIMITED Manton Lane, Bedford

SITUATIONS VACANT (Cont'd.)

SOMEWHERE IN ENGLAND the man we want. Is it you? A unique appointment is open to an Electronic Production Engineer capable of running the manufacturing side of a rapidly growing company producing specialised electronic equipment. Success will lead to early promotion as General Manager, and the door to the Boardroom is wide open! If you are young, ambitious and energetic—have the right experience—if you are not afraid of long hours and above all, if you are dedicated to your career, this is your big opportunity. Applications will be treated in the strictest confidence and should be made to the Managing Director, Box W 5160.

YOUNG ELECTRONICS ENGINEER required by well-known London firm of Chartered Patent Agents with expanding electrical practice. Should have Honours Degree, be aged 25 or under and be prepared to study for qualifications as Chartered Patent Agent. Man graduating this year might be suitable. Write, giving full particulars as to age, qualifications, etc., Box No. G4505 c/o Whites, 72 Fleet Street, London, E.C.4. W 5095

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YOUNG MAN, AGED 28, single and able to travel, wishing to enter radio engineering, seeks post where he could obtain experience and qualifications. Teaching at present, he has a working knowledge of elementary radio theory but is without industrial experience. Will someone take a chance on intelligence rather than experience? Box No. W 2031.

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50,000 PRECISION INSTRUMENT GEARS of all types from stock. (Now including spiral bevels.) Write for fully comprehensive catalogue. The Davall Gear Company Limited, Potters Bar, Middlesex (Telephone No. Potters Bar 2382). W 357

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PATENTS

PATENT NO. 797,599 entitled "Electrical Connector, particularly for the Pins of a Valve" is for sale or licence. For details apply to Chatwin & Company, Chartered Patent Agents, 253, Gray's Inn Road, London, W.C.1. W 5145

PATENT NO. 797,136 entitled "Filament Lead-in and Impedance Matching Structure for a Grounded Grid Amplifier" is for sale or licence. For details apply to Chatwin & Company, Chartered Patent Agents, 253, Gray's Inn Road, London, W.C.1. W 5144

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(Faculty of Technology in the University of Manchester)

Appointment of

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Applications are invited for Lectureships in Electrical Engineering with equivalent status in the University of Manchester.

Salary will be in the scale £1,050 × £50—£1,400 × £75—£1,850 with family allowances and F.S.S.U.

The conditions of appointment and form of application may be obtained from the Registrar, the Manchester College of Science and Technology, Manchester, 1. The last date for the receipt of applications is *12th May, 1961.*

ME announce the following vacancies in their expanding organisation which is pleasantly situated on the South Coast.

Senior Engineer to investigate interesting problems in the field of visual simulation. Applicants with good academic qualifications and design experience of optical/electronic equipment are invited to apply.

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Design Engineers for design and development of systems and equipment used in the above fields. The problems likely to be met are both varied and absorbing.

Senior Electro Mechanical Draughtsmen with experience of small electro-mechanisms and instruments.

Electronic Draughtsmen with experience of chassis design and layout and capable of producing circuit diagrams to publication standard.

Attractive salaries with pension rights are offered and applicants are invited to send full particulars of experience and qualifications, stating position applied for, to

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MILES ELECTRONICS LTD.
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DEVELOPMENT ENGINEER

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for electronic resistance welding controls. Knowledge of welding and welding industry essential. Controls are of advanced design and used by leading manufacturers. Position offers considerable prospects to forward looking person having technical knowledge, drive and experience.

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One of the most progressive electronics companies offers an outstanding opportunity for a man with the right qualifications to work in a pleasant and healthy seaside atmosphere yet within an hour's train ride from London.

The successful candidate will take control of a team engaged in the design of microwave components, duplexers and aerial systems. Qualifications up to degree standard, and experience in this field are essential.

There are also excellent openings for both senior and junior engineers to work on a wide variety of special components in the radar field.

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Ferranti computers

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require

SENIOR DESIGN AND DEVELOPMENT ENGINEERS

for work associated with the design and development of the latest Ferranti range of digital computers.

These are senior posts and candidates should have a degree in electrical engineering or H.N.C. coupled with first-class experience in the development of electronic equipment (not necessarily computers). Salary scales and general conditions of employment will reflect the seniority of these appointments. Where necessary supplementary training will be given.

Applications should be made in writing to

T. J. Lunt, Staff Manager, Ferranti Limited, Hollinwood, Lancs.

giving brief details of qualifications and experience. Please quote reference KLD.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

PRODUCTION GROUP

INSTRUMENT MECHANICS

Windscale and Calder Works, and Chapelcross Works require experienced men with knowledge of electronic equipment and/or industrial instrumentation for fault diagnosis, repair and calibration of a wide range of instruments used in nuclear reactors, radiation laboratories and chemical plant. This interesting work involves the maintenance of instruments using pulse techniques, wide band low noise amplifiers, pulse amplitude analysers, counting circuits, television, and industrial instruments used for the measurement of pressure, temperature and flow.

Men with Services, Industrial or Commercial background of radar, radio, television, industrial or aircraft instruments are invited to write for further information. Training Courses in Specialised Techniques are provided for successful applicants having suitable instrumentation background. Married men living beyond daily travelling distance will be eligible for housing. A lodging allowance is payable whilst waiting for housing. Working conditions and promotion prospects are good.

Applications to:—

Works Labour Manager, Windscale and Calder Works, Sellafield, Seascale, Cumberland.

or

Works Labour Manager, Chapelcross Works, Annan, Dumfriesshire. Scotland.

TRANSISTOR CIRCUIT ENGINEER

A Senior Engineer, preferably with qualifications, is required by a leading component manufacturer.

At least three years' previous Transistor experience is essential, preferably, but not essentially in commercial Radio and Television.

Applicants should be under the age of 40. This Staff appointment carries a good Salary and Pension Scheme, etc.

The factory is situated in a pleasant part of the South Coast with excellent facilities for both technical and general education, sailing and sport.

Write giving full particulars to:

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Sydney S. Bird & Sons Limited
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Interesting and progressive posts are available in TRIALS DEPARTMENT of the expanding Weapons Research Division of A. V. Roe & Co. Ltd., at Woodford, Cheshire.

The Division is engaged upon the design and development of the air-to-ground strategic guided missile for the R.A.F. 'V' Bomber Force—Blue Steel.

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4. MECHANICAL TECHNICIANS

of O.N.C. standard to assist the above, with prospects of promotion on qualification.
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The Division is situated on an airfield in rural Cheshire close to housing and shops and on main bus routes. A Superannuation scheme is in operation and there are good Canteen facilities.

Apply quoting Ref. No. WRD/TA/R. 118/D, and stating which post/s of interest to:

Personnel Manager

A. V. ROE & CO. LTD.

GREENGATE MIDDLETON MANCHESTER

DATA RECORDING INSTRUMENT COMPANY LIMITED

require an

ELECTRONICS ENGINEER

to assist with the development and construction of digital tape recording equipment.

Applicants should possess O.N.C. qualification or equivalent.

The initial salary will be in the range £700-£750 depending on age and experience.

The Company operates a superannuation fund and its expansion programme offers excellent opportunities for advancement.

Applications, which will be treated in confidence, giving details of career should be addressed to

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RHOANGLO MINE SERVICES LIMITED

Kitwe, Northern Rhodesia

INSTRUMENTATION ENGINEER

Applications are invited for the post of Instrumentation Engineer in the company's Instrumentation Division, which has become vacant as the result of promotion and expansion.

The Division serves the Northern Rhodesian mining companies of the Group controlled by Anglo American Corporation of South Africa, Limited, which are large-scale producers of copper, cobalt, lead and zinc.

DUTIES. The Division is under the direction of the Senior Instrumentation Engineer and the successful candidate would be his deputy in charge of the present staff of six technicians.

The Instrumentation Engineer would be required to assist in devising instrumentation systems for special problems in the fields of mining, ore dressing, leaching, roasting (fluid bed, hearth and kiln), electrowinning and refining, including measurement and control devices for pressure, temperature, weighing, flow and pulp density measurement, etc. He would also assist with the planning, commissioning and development of instrumentation in the production plants, and with the substantial amount of service and standardisation work which is undertaken.

A wide knowledge of commercially available units which can be incorporated in instrumentation systems is essential, and the ability to devise, design and direct the practical construction and installation of new "one-off" units for special purposes is also required.

PAY, etc. The commencing basic salary will be determined by qualifications and experience but will not be less than £1,674 per annum—plus a bonus, varying with the prosperity of the industry, which is at present approximately 40% of basic salary, and a variable cost-of-living allowance which is at present about £60 per annum. Excellent modern housing, complete with basic furniture, refrigerator, etc., is provided at a nominal rental. There are also generous pension, life assurance and medical benefits. Leave varies between 48 and 51 days per annum, depending on salary, and may be accumulated for up to three years. Air or sea passage for the successful candidate would be paid by the company and assistance may be provided towards other importation expenses. Income tax rates are low.

GENERAL INFORMATION. Kitwe is situated on the Central African plateau at an altitude of 4,100 feet above sea level and consequently enjoys an equable, healthy climate of dry cool winters with a rainy season moderating summer temperatures.

Ample all the year round facilities for all the usual sports are available. Two modern cinemas offer daily programmes. Numerous recreational societies are active in the town, which has a population of about 12,000 Europeans. A television service is expected to commence in a few months.

Education at the Government schools is free. Several modern and well-equipped primary schools cater for the younger children. The boys' high and girls' high schools prepare pupils for the usual school leaving certificates and university entrance examinations.

APPLY BY AIRMAIL TO The Secretaries,
P.O. Box 172,
Kitwe,
Northern Rhodesia.

Stating age, marital status, qualifications, experience record, availability, and the names of two referees, and enclosing a recent photograph

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LEO

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Applications are invited from young men for maintenance of large-scale computer installations. The work involves testing, fault diagnosis and maintenance of a large volume of fully transistorised electronic circuits.

Applicants should have a degree, H.N.C. or similar qualification together with some practical experience of electronic work. Men with appreciable experience but without qualifications will be considered.

Comprehensive training will be given and excellent prospects exist in the Company which is expanding rapidly.

Details of experience, qualifications, age and present salary should be sent to:

Personnel Manager,
LEO Computers Limited,
Hartree House,
151A-159A Queensway, London, W.2.

NATIONAL INSTITUTE FOR RESEARCH IN NUCLEAR SCIENCE

Technical Staff

Technical staff with Electronics experience are required by the National Institute for Research in Nuclear Science at the Rutherford High Energy Laboratory, Harwell, Berkshire.

The successful applicants will be members of a small team engaged in setting up and calibrating a wide range of electronic and electrical instruments.

Applicants should have had a recognised engineering apprenticeship or have had equivalent training. It would be an advantage to possess an Ordinary National Certificate. Experience in the repair, fault finding and calibration of general electronic and physical instruments is required.

Salaries are in the scale £885 (at age 26) to £1,210.

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Please send a POST CARD for an application form to the Personnel Officer,

The Rutherford High Energy Laboratory,
Harwell, Didcot, Berks.

quoting reference VN 47/42.

RESEARCH AND DEVELOPMENT APPOINTMENTS IN CAMBRIDGE

An extensive, long-term development programme in a spacious, new laboratory enables us to offer progressive and permanent positions to the right type of design engineers.

Initially, there are three vacancies for

Circuit Engineers

having sound experience with the use of transistors, and one vacancy for a thoroughly practical

Mechanical Designer

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Our own Staff have been notified about these vacancies.

Applications will be treated as confidential.

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CAMBRIDGE.

(Telephone 88022).

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a number of

ELECTRICAL ENGINEERS

for the testing and commissioning of the electrical systems in Naval nuclear reactor installations. The work covers the preparation of system test specifications and the technical supervision of testing in the fields of reactor instrumentation, control and protection; power generator and distribution and machinery control.

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There are long term prospects in systems design work for which this project will form an excellent basis.

This opportunity will primarily interest the young Engineer seeking to widen his experience, but mature Engineers with possibly a relevant Service background would be suitable for some of the posts.

Salaries will be based on qualifications and experience.

Applications should be addressed to the

Chief Electrical Engineer
VICKERS-ARMSTRONGS (SHIPBUILDERS) LTD.
Barrow-in-Furness, Lancashire.

Delapena

Offer an opportunity in an out-of-the-ordinary branch of Electronic Engineering to a

DEVELOPMENT ENGINEER

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TEST EQUIPMENT
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The Personnel Officer
M-O Valve Co. Ltd.
Brook Green, Hammersmith, W.6

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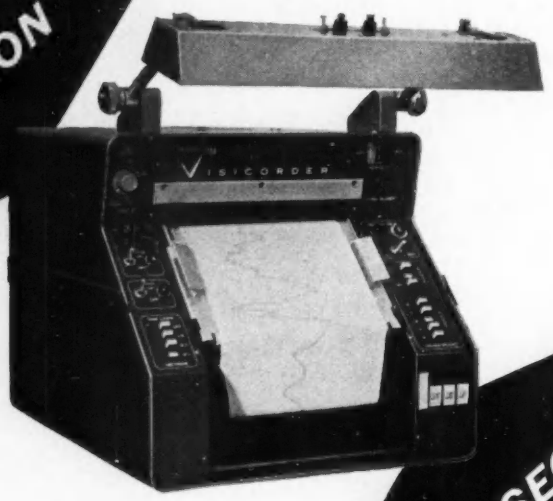

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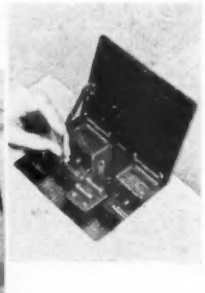

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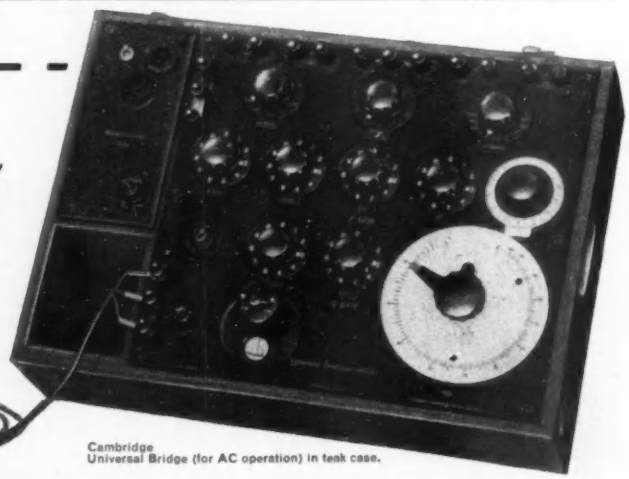

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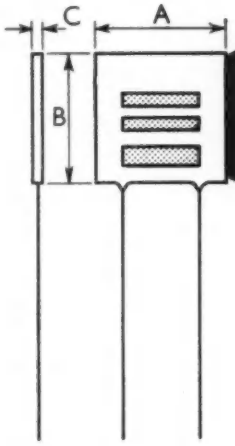

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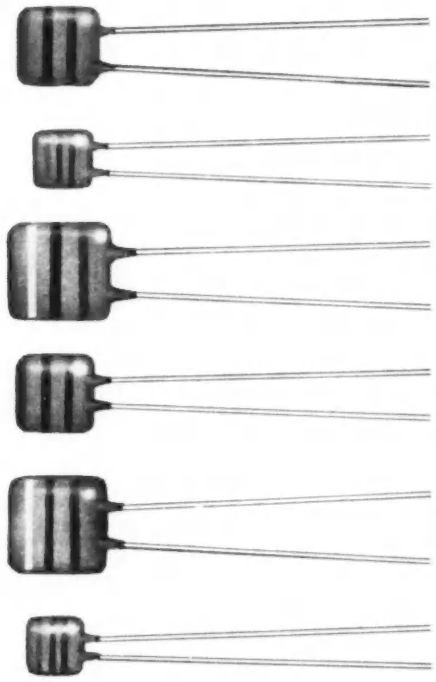

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